A statistical analysis of China's patent quality situation and larger innovation ecosystem

Prud'homme, Dan

August 2012

A statistical analysis of China's patent quality situation and larger innovation ecosystem[+]

Dan Prud'homme[*]

August 2012

Abstract: While patent filings in China have been exploding in recent years, analysis based on a variety of metrics shows that this increase has not necessarily translated into a 'proportionate' rise in patent quality. Further, based on projections quantifying "highest quality" patents in China, there is reason for concern that in the near future the country's patent ecosystem may be less composed of highest-quality patents than some policymakers envisaged. In terms of its innovation capacity at large, metrics suggest that China indeed has a growingly impressive innovation potential, although its actual innovation output appears overhyped by some sources.

Keywords: patent quality, China, patent quality metrics, innovation metrics, utility model patents

[+] This paper is Chapter 1 of Prud'homme, D. (2012) *Dulling the Cutting Edge: How Patent-Related Policies and Practices Hamper Innovation in China*, European Union Chamber of Commerce in China Publications

[*] Manager, IPR and R&D groups at European Union Chamber of Commerce in China

Ⅲ Results

Ⅲ.1 Chapter 1: Statistical analysis of China's patent quality situation and larger innovation ecosystem

Ⅲ.1.1 Analysis

Ⅲ.1.1.1 Sub-section 1.1: Patent filings have exploded, but this has not translated into a proportional rise in patent quality

Introduction: This sub-section explores how China measures up on a wide range of patent statistics[1] and what this reflects in terms of the patent quality situation in China. Herein, this section finds that the claims made by an increasing number of sources that China's recent patent filing explosion shows it is well on its way to become an impressively innovative economy need better contextualisation, as while patent quality in China is rising in some sense it does not appear to be 'proportionally' keeping pace with patent filings.

Ⅲ.1.1.1.1 A patent explosion

China has explosively increased its domestic filing of patent applications over the years, becoming the world's top patent filer in 2011, surpassing the US' and Japan's rate of domestic filings.[2] Since 1985, the year the first Chinese *Patent Law* was released and implemented, there has been a significant increase in the number of invention patent, utility model, and design patent filings in China.

This development has likely been enabled by a number of factors. One likely contributor is improvement in regulation surrounding patents, which, among other effects, has led to improvements in the patent review process – for example, the examination period for invention patents has been reduced from 53 months in 2001 to less than half of that in 2010.[3] A variety of socioeconomic factors (e.g. rise in the educated workforce) and economic competition have likely led to the growing capacity and drive of Chinese entities to file patents. Additionally, as discussed throughout this study, although not necessarily widely measured by empirical evidence, a variety of patent-related incentives and other policies may have in part encouraged this surge in absolute numbers of patents.

Despite this explosion of patents, it is important to keep in mind that China still somewhat lags behind a number of other innovative countries in terms of patent filings per capita. Per capita measures provide necessary context to date, and in the case of patent filings, arguably better reflect penetration rates of invention capacity than absolute patent filings. As one illustration of this trend, Table 3 below illustrates that China's invention patent filings/the equivalent thereof by domestic entities per capita lag behind a sample of other countries.

[1] Note: As this section relies heavily on patent statistics from SIPO, it is important to note that SIPO's figures for "domestic" filings do not differentiate between filings made by Chinese-controlled entities or certain foreign-invested entities in China.
[2] Lee, C. Y. (2011, December 21). China tops US, Japan to become top patent filer. *Reuters*. Retrieved from http://www.reuters.com/article/2011/12/21/us-china-patents-idUSTRE7BK0LQ20111221
[3] Gao et al. (2011), p. 13

Table 3: Patent filings by domestic entities in sample countries per capita (2010)

Country	Number of patents filed by domestic entities (equivalent invention patents in China) (WIPO, 2010)	Population (1,000) (OECD, 2010)	Patent filings in country per capita (per 1,000 people)
Japan	290,081	128,057	2.3
US	241,977	309,050	0.8
Germany	47,047	81,777	0.6
Austria	2,424	8,389	0.3
Denmark	1,626	5,548	0.3
China	293,066	1,341,335	0.2

Source: WIPO, OECD; calculations

Ⅲ.1.1.1.2 Types of patents filed to date

By industry, and service vs. non-service invention

In terms of industries, from 1995-2004, the largest number of domestically filed patents were for machinery, chemicals, and telecommunications equipment, respectively.[4] Similarly, in 2010 the highest number of patents filings was concentrated in electrical machinery, digital communication, computer technology, measurement instruments, and pharmaceuticals.[5]

Overall, from 1985-2010, the vast majority of invention patents filed were on service inventions, and, due to the filing habits of domestic filers, most utility and design patents were filed for non-service inventions. This said, while the averages from 1985-2010 provide a general idea of trends in filings, it is worth noting that in recent years domestic filers are filing more service utility models than non-service utility models (e.g. in 2010, 61.1% of domestic enterprises' utility models were for service solutions and 38.9% were for non-service solutions).[6] It is also worth noting that the vast majority of invention patents "in-force" (a term explained further below in section "Ⅲ.1.1.1.4 Core measures of patent quality") owned by domestic and foreign entities during time periods reviewed in this study were service patents.[7]

[4] Hu, A. G. (2010). Propensity to patent, competition and China's foreign patenting surge. *Research Policy*, Vol. 39, 985-993. Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733310001101

[5] Stembridge, B. (2011). *Chinese patenting: Report on the current state of innovation in China*. Thomson Reuters. Retrieved from http://ip.thomsonreuters.com/

[6] State Intellectual Property Office. (2011, January 25). *Grants for three kinds of patents received from home and abroad (January 2010-December. 2010)*. A SIPO Statistics. Retrieved from http://english.sipo.gov.cn/statistics/gnwsqnb/2010/201101/t20110125_570600.html

[7] Note: In 2010, out of the patents in-force held by Chinese owners, 81.3% were service inventions (and 18.7% non-service inventions), and out of those held by foreigners, 97.9% were service inventions (and 2.1% were non-service inventions). (Source: Gao et al. [2011], p. 32)

Table 4: Total applications for three patents types received from home and abroad (1985-2010)

May 1985-December 2010									
		Invention		Utility Model		Design		Total	
		Number	%	Number	%	Number	%	Number	%
Total	Sub-total	2,325,012	100.0	2,414,324	100.0	2,298,238	100.0	7,037,574	100.0
	Service	1,825,487	78.5	969,048	40.1	1,011,142	44.0	3,805,677	54.1
	Non-service	499,525	21.5	1,445,276	59.9	1,287,096	56.0	3,231,897	45.9
Domestic	Sub-total	1,429,648	100/61.5	2,397,523	100/99.3	2,173,289	100/94.6	6,000,460	100/85.3
	Service	960,761	67.2	955,832	39.9	891,690	41.0	2,808,283	46.8
	Non-service	468,887	32.8	1,441,691	60.1	1,281,599	59.0	3,192,177	53.2
Foreign	Sub-total	895,364	100/38.5	16,801	100/0.7	124,949	100/5.4	1,037,114	100/14.7
	Service	864,726	96.6	13,216	78.7	119,452	95.6	997,394	96.2
	Non-service	30,638	3.4	3,585	21.3	5,497	4.4	39,720	3.8

Source: Directly adapted from SIPO statistics chart[8]

By type of patent (invention, utility, and design), and origin of filer

It is clear that domestic filers are strongly contributing to China's increased patent filings; however, deeper analysis uncovers a potentially concerning recent trend: in 2010 and 2011, domestic filers drove China's total utility model filings to in fact outpace filings of invention patents. This trend diverges from that during the last decade in terms of having invention patents increasingly replace utility models, reflecting a recent disproportionate rise in less-than-highest-quality patents (even if one assumes all invention patent filings are of highest-quality).[9] In further illustrating these points, the below sections illustrate trends in average annual growth rates (AAGR) of patent applications to date, and absolute numbers of patent filings to date.

AAGR of applications for different patents in China to date

Despite notable growth of applications for both utility model and invention patent applications, in the last five years in particular, the growth rate of utility model filings has notably outpaced that for invention patent filings and is a trend led by domestic filers. Drawing from calculations in Table 5 and Table 6 below (more calculations are presented in the "Chapter 1" section in the Annex), it is apparent that while total (from foreign and domestic filers) invention patent applications grew at a higher AAGR than utility models from 1997-2001 and from 2002-2006, from 2007-2011 the AAGR of total utility model applications significantly outpaced the AAGR for total invention patent applications. Specifically, from 2007-2011, the AAGR for total utility model applications was 9 percentage points higher than that for total invention patents. Further, from 2007-2011 the AAGR of utility model filings by domestic entities (30%) has been higher than at any other time in the prior

[8] Retrieved from http://english.sipo.gov.cn/statistics/szslzljb/201101/t20110125_570591.html

[9] At worst, this increased filing of less-than-highest-quality patents could also include a disproportionate rise in low-quality patents, although more evidence would need to be gathered to better determine if this is happening.

decade. And this rate was higher than the AAGR for domestic entities filings of invention patents during the same period (28%), and exponentially higher than the AAGR for foreign filings of invention patents during the same time period (5%). (Note: while the growth rate of foreign utility model applications was notably high from 2002-2006 [32%] and 2007-2011 [27%], given, as illustrated in the "Chapter 1" section in the Annex, such applications make a relatively insignificant amount of absolute number of utility model filings compared with those from domestic filers, they thus have a very small impact on the total patent filing AAGR.) This reflects that recently there is a trend towards a disproportionate rise in filings of less-than-highest quality patents.

Table 5: Invention patent applications in China: AAGR (%) by filer and five year period

Five year time period	Domestic apps. AAGR	Foreign apps. AAGR	Total (domestic + foreign) AAGR
1997-2001	23	15	18
2002-2006	33	22	27
2007-2011	28	5	21

Source: Calculations in "Chapter 1" in the Annex. All percentages are rounded.

Table 6: Utility model applications in China: AAGR (%) by filer and five year period

Five year time period	Domestic apps. AAGR	Foreign apps. AAGR	Total (domestic + foreign) AAGR
1997-2001	10	15	10
2002-2006	15	32	15
2007-2011	30	27	30

Source: Calculations in "Chapter 1" in the Annex. All percentages are rounded.

A number of trends are visible when analysing the AAGRs for design patent applications (see Table 7 below, and the "Chapter 1" section in the Annex for more details). The AAGR of domestic entities' filings of design patents fell in 2007-2011 (22%) from the rate in 2002-2006 (27%). The AAGR for foreign entities' filings of design patents plunged in 2007-2011 (2%) compared with the rates of their filings in 2002-2006 (26%). The AAGR of total design patent applications from 2002-2006 (28%) was higher than the AAGR for total invention patent applications in the same period, and also higher than the total utility model applications during the same period.

Table 7: Design patent applications in China: AAGR (%) by filer and five year period

Five year time period	Domestic apps. AAGR	Foreign apps. AAGR	Total (domestic + foreign) AAGR
1997-2001	21	7	20
2002-2006	27	26	28*
2007-2011	22	2	19

Source: Calculations in "Chapter 1" in the Annex. All percentages are rounded.*Reminder: number due to rounding.

Absolute numbers of filings by type of patent/model to date, and ratios

Further to the above discussion, analysis of absolute numbers of patent filings shows utility models outpacing filings of invention patents in recent years, which is a trend led by domestic filers. Table 8 below illustrates that in terms of absolute numbers, in 2004, for the first time during the sample period of 1996-2011, more total invention patents were filed than total utility models; however, in 2010 and 2011, more total utility models were filed than total invention patents, meaning patent filing trends have recently shifted to pre-2004 type of ratios. (Additionally, the statistics presented in the "Chapter 1" section in the Annex show that from 1996-2011 domestic filers have filed and continue to file overwhelmingly more utility model applications than foreign filers, although this

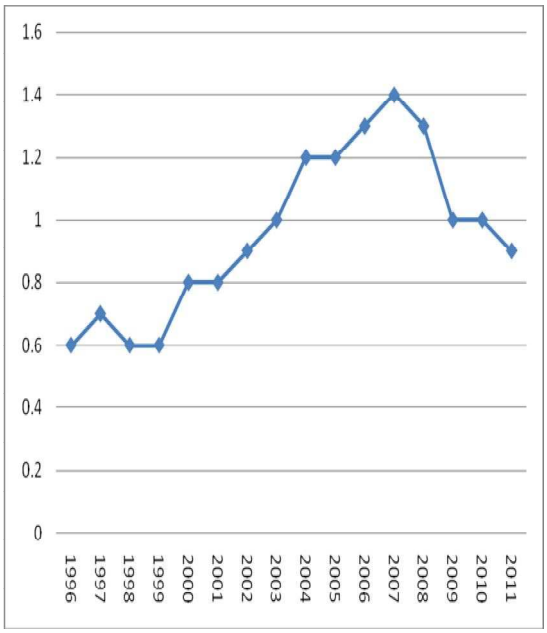
trend, as discussed in the below section "Filing ratios put in an international perspective," is shared in sampled European countries.) As further illustrated by the ratio of invention patents filings to utility model filings, as shown in Chart 2 below, These trends reflect that China in recent years is witnessing a disproportionately small filing of highest-quality patents.

Table 8: Total (by domestic and foreign filers) invention patent vs. utility model apps. in China (1996-2011)

Year	Invention Patents	Utility Models	Ratio*
1996	28,517	49,604	0.6 : 1
1997	33,666	50,129	0.7 : 1
1998	35,960	51,397	0.6 : 1
1999	36,694	57,492	0.6 : 1
2000	51,747	68,815	0.8 : 1
2001	63,204	79,722	0.8 : 1
2002	80,232	93,139	0.9 : 1
2003	105,318	109,115	1 : 1
2004	*130,133*	*112,825*	*1.2 : 1*
2005	173,327	139,566	1.2 : 1
2006	210,490	161,366	1.3 : 1
2007	245,161	181,324	1.4 : 1
2008	289,838	225,586	1.3 : 1
2009	314,573	310,771	1 : 1
2010	*391,177*	*409,836*	*1 : 1*
2011	*526,412*	*585,467*	*0.9 : 1*

Source: SIPO statistics database; calculations.
*Ratios are approximations.

Chart 2: Total invention patent vs. utility model applications in China by ratio (1996-2011)



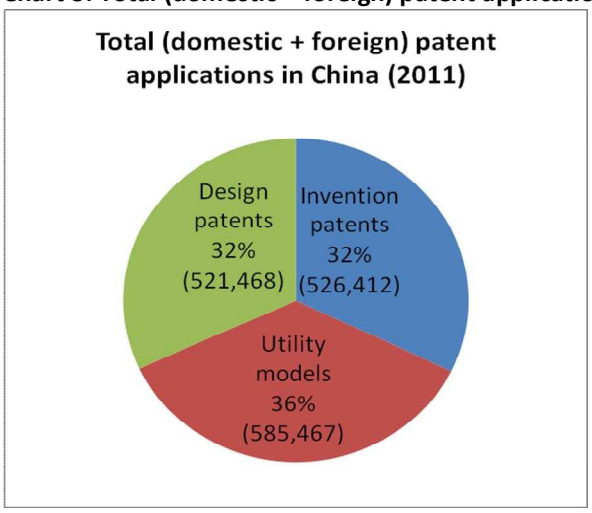
Source: SIPO statistics; calculations. Ratios are approximations

It is also worth noting that domestic filers have filed and continue to file overwhelmingly more design patent applications than foreign filers. For further analysis/comparisons of patent filing trends by type of application and filer, including but not limited to those for design patent applications, see the "Chapter 1" section in the Annex.

Snapshot: Patent filings in China in 2011

Chart 3 illustrates that total utility model applications, which make up 36% of all patent applications filed last year (2011), were 4 percentage points higher than the respective number of invention patent and design patent applications (32% for both) as a proportion of total patent filings. Comparing the absolute numbers directly, there were 11% more total utility model filings than total invention patent filings in China in 2011.

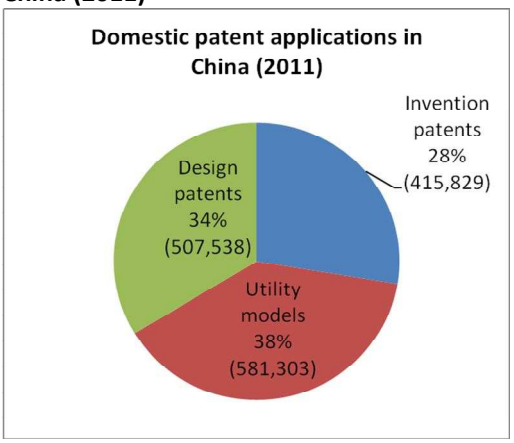
Chart 3: Total (domestic + foreign) patent applications in China (2011)



Source: SIPO statistics; calculations

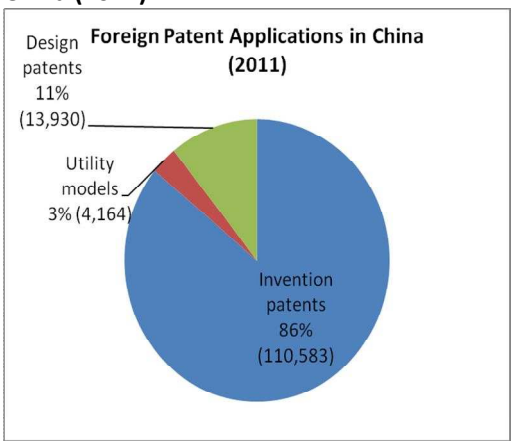
Further, Chart 3 above and Charts 4 and 5 below illustrate that in 2011 domestic applicants led the trend of more utility model applications being filed in China than invention patents or design patents. Chart 4 shows that as a proportion of their total patent filings, domestic applicants filed more utility models than invention patents (and more utility models than design patents). Comparing the absolute numbers directly, domestic applicants filed roughly 40% more utility model than invention patents. Chart 5 shows that the vast majority of foreign patent applications in China in 2011 were for invention patents (86%), whereas only 3% were for utility models (and 11% for designs). This reflects that domestic applicants are largely responsible for the recent disproportionate filing of less-than-highest-quality patents in China.

Chart 4: Domestic patent applications in China (2011)



Source: SIPO statistics; calculations

Chart 5: Foreign patent applications in China (2011)



SIPO statistics; calculations

Filing ratios put in an international perspective

As illustrated in the "Chapter 1" section in the Annex, when comparing the ratio of utility model applications vs. invention patent applications in China to several EU countries with broadly similar patent regimes (in so much as they also protect invention patents, utility models, and design

patents),[10] it is apparent that patent filings in the EU countries are significantly more geared towards invention patent filings and those are more so led by domestic applicants. In recent years (2008-2010 being the sample period reviewed) more domestic applicants than foreign applicants in Austria, China, Denmark, and Germany filed utility models through their domestic patent offices. However, unlike in China, far more invention patents were filed in the aforementioned EU countries than utility models in terms of both total applications and in terms of those from domestic filers specifically.[11] Subject to contextualisation about the difference in the countries utility model and invention patent systems, these trends generally reflect that China's patent filings lean much more towards less-than-highest-quality patents when juxtaposed with a variety of EU countries with broadly comparable patent systems.

Distribution of patents among entities in China

Snapshot: Dispersion of different types of patents by type of company

With some exceptions, invention patents are dispersed across a wide variety of entities in China. Over a 20 year period reviewed, and within a sample of firm data from China's top 500 companies, Zheng and Lan (2009), found that five corporations -- Huawei Technology Ltd., China Petroleum and Chemical Group, Lenovo, and lastly, ZTE Corporation — accounted for over 60% of all of domestic firms' invention patents in the sample (see Table 9 below). While this shows a high concentration of patent filings amongst just a few firms in the sample, the sample itself was only representative of less than 5% of total domestic invention patent filings whereas over 95% of invention patents filed in the same 20 year period were from firms outside China's top 500 firms. This shows a high concentration of invention patent filings among some of China's top 500 companies, but Zheng and Lan find notable dispersion of the majority of invention patent filings among different domestic entities in China.[12]

Table 9: Domestic enterprises with over 200 invention applications during 1984-2004

Corporation	Number
Huawei Technologies Co., Ltd	5,365
China Petroleum & Chemical Ltd.	2,093
China Petroleum and Chemical Group	782
Lenovo Ltd.	745
ZTE Corporation	739
China Petroleum & Chemical Corporation	458
Petro China Company Limited	346
Baosteel Ltd.	325
Haier Ltd.	256

Source: Zheng and Lan (2009)[13]

Rather than go into an exhaustive analysis, it is sufficient to note that, as further illustrated in the "Chapter 1" section in the Annex, entities with different legal registration statuses in China typically

[10] Although there are still some notable differences in these countries patent systems which must be considered when making such a comparison.

[11] Note: these figures are exclusively representative of the aforementioned European countries' patent filings in their own country's patent offices, not at the European Patent Office (EPO). As also illustrated in the "Chapter 1" section in the Annex therein, filers originating in those countries can and certainly do also file notable amounts of patents with the EPO.

[12] Zheng, L., & Lan, X. (2009). A tale of two cities: A comparison of patent-based innovative performance of domestic and multinational companies in China. Proceedings of the Joint Symposium of US-China Advanced Technology Trade and Industrial Development. *Journal of International Commerce & Economics*, 3(1), p. 32 Retrieved from http://www.usitc.gov/journals/entire_journal_2010_11_4.pdf

[13] Zheng and Lan (2009), Table 4, p. 33

file different percentages of invention patents, utility models, and design patents. By way of one example, the patent filing characteristics of Chinese SOEs are singled out for further discussion in the below section.

SOEs in particular

Chinese SOEs, despite their support from the government, arguably perform less than optimally in terms of producing patented products and services. From one perspective, for example looking at the data in Table 9 above, some Chinese SOEs in fact produce relatively significant numbers of patents. However, this is not widespread across all SOEs in China. According the data and calculations in the "Chapter 1" section in the Annex, in 2009 (2009 is used as a proxy year given it is a recent year and all relevant data is readily available for that year whereas data is not readily available for other recent years), out of all medium- and large-sized domestic-funded Chinese entities, Chinese SOEs accounted for 10% of all patent applications, 9% of all invention patent filings, and 10% of all utility and design patent filings. Their filings of utility and design patents made up 65% of the total number of patent applications they filed that year (35% were for invention patents), which is a higher percentage of utility and design patents than a number of other enterprises with different legal registration, although was also lower than that of a number of other enterprises with different legal registration.[14] While on one hand it could be argued that these figures show that SOEs do not file insignificant amounts of patents, they also show that SOEs could certainly be filing more patents, and, importantly – just as a number of other domestic enterprises could – file more invention patents instead of design and utility models. Moreover, Chinese SOEs arguably should be producing better patent figures given the level of financial and other support they enjoy from the government in an attempt to make them innovative and competitive. (R&D figures of Chinese SOEs and their scores on other innovation metrics are mentioned in section "Ⅲ.1.1.2.1 Fundamental metrics of innovation outside patent statistics")

International patent filings by China-based entities

International patent applications are a decent measure of the desire of filers to actually use or at least protect their inventions abroad. Patent Cooperation Treaty (PCT) applications and triadic patent applications, among other metrics, gauge international patent filings.

PCT applications – Commendably, China ranks in the top five in the world for PCT applications. It filed a total of 16,406 PCT applications in 2011, at an annual growth rate of 33.4% which was the highest in the world.[15] Still, this should at least be contextualised in that a few companies, like ZTE and Huawei clearly lead these numbers (see Table 10).

[14] Note 1: "State-owned Enterprises" are distinguished in National Bureau of Statistics records from "State Joint Ownership Enterprise" and "State-Sole Funded Corporation." Note 2: Statistics only readily available for medium- and large-sized enterprises, thus excluding smaller enterprises.

[15] China IPR (2012, April 5). *China boasts sharpest growth in PCT applications*. Retrieved from http://www.chinaipr.gov.cn/newsarticle/news/government/201204/1287307_1.html

Table 10: PCT Applications Published in 2011, by top 5 applicants

Ranking	Applicant's name	PCT App. Pub. in 2011	Change from 2010 (number)
1	ZTE Corporation	2,826	958
2	Panasonic Corporation	2,463	310
3	Huawei Technologies Co. Ltd.	1,831	304
4	Sharp Kabushiki Kaisha	1,755	469
5	Robert Bosch Corporation	1,518	217

Source: WIPO statistics[16]

DWPI – Outside of PCT filings, another metric to measure "global" filings is the Thomas Reuters Derwent World Patents Index (DWPI), which measures published patent applications in Europe, China, Japan, South Korea, and the US. A 2011 report using this database noted marked rises in Chinese applications in recent years, on the order that will likely soon compete with filings from Japan and the US, the biggest current filers in the DWPI. The report noted that as of 2010, the highest DWPI shares of domestic Chinese applications, i.e. the ratio of Chinese domestic applications to applications in the DWPI, are concentrated in pharmaceuticals (58% in traditional medicines), food chemistry and basic materials chemistry, followed by biotechnology and digital communication.[17]

Triadic patent filings – China does not score particularly well on per capita triadic patent filings, an arguably more appropriate measure of invention capacity than absolute patent filings. OECD (2011b), finds that China ranks comparatively low out of countries sampled (OECD countries as well as several non-OECD countries) in terms of per capita filings of triadic patent family filings, i.e. patents filed at the European Patent Office (EPO), Japan Patent Office (JPO), and US Patent and Trademark Office (USPTO) to protect the same invention.[18]

Other metrics – Also, on yet other metrics of international filings, Chinese enterprises have only been granted a miniscule amount of patents abroad. In fact, sources suggest that patent offices outside China only have granted 1% of their patents to China-based entities, and half of these patents were granted to subsidiaries of foreign multinational enterprises.[19]

Ⅲ.1.1.1.3 Estimates of patent filings in China in 2015

Not only are patent applications in recent years being dominated more so by utility models than invention patents (or design patents), but, according to calculations in this study illustrated in Chart 6 below, these trends are on course to continue through 2015. In fact, by 2015, it is possible that there will be 39% *more* (over 430,000) total utility model applications than total invention patent applications. This would be 28 percentage points more than the 2011 percentage at which utility model applications outnumbered invention patent applications (11%). When comparing Chart 6 below with Chart 3 above, this estimated 2015 growth in utility model applications (who make up

[16] WIPO. (2012, March 5). *International patent filings set new record in 2011*. Retrieved from http://www.wipo.int/pressroom/en/articles/2012/article_0001.html

[17] Stembridge (2011). Note: 58% figure based on calculations from data on p. 15 therein.

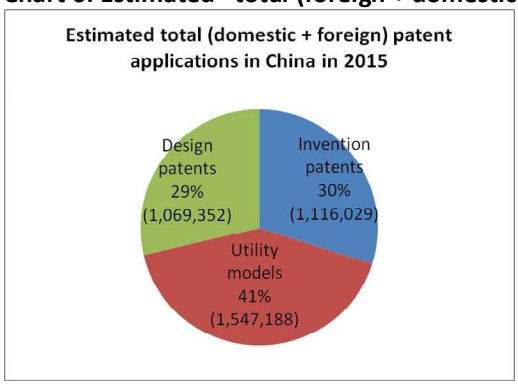
[18] OECD. (2011b). *OECD Science, Technology and Industry Scoreboard 2011*. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/sti_scoreboard-2011-en. Note: OECD (2011b) finds that triadic filings are typically of higher value and "eliminate biases from home advantage and influence of geographical location." (p. 45)

[19] China's innovation capacities may be over-hyped. (2011, August 7). *International Business Times*. Retrieved from http://www.ibtimes.com/articles/193820/20110807/china-innovation-railway-patent-education-system-academic-fraud.htm

41% of total applications) is at the expense of proportionate growth in invention patent (and design patent) applications, whereas invention patent (and design patent) filings as a proportion of total patent filings is predicted to actually fall in 2015 compared to 2011 by 2 percentage points (and 3 percentage points, respectively). In other words, in 2015 invention patents will make up a smaller percentage of total patent filings than they do today while utility models will make up a larger percentage.

By way of further example, the projections suggest there will be over 2.6 million less-than-highest-quality patents filed in 2015 alone. This includes the utility models and design patents for the reasons explained in the Introduction to this study. Even if all the invention patents estimated as being filed in 2015 were considered to be highest-quality patents, this would still mean there would be substantially more less-than-highest-quality patents than highest-quality patents filed in 2015.

Chart 6: Estimated* total (foreign + domestic) patent applications in China in 2015

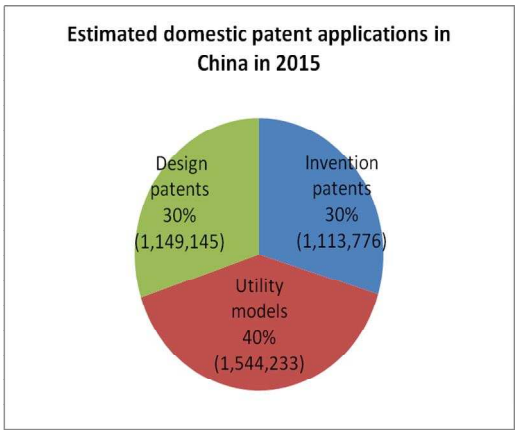


Source: *Methodological Approach A discussed in the "Chapter 1" section of the Annex

Further, the projections find that this increase in the amount of utility model applications as a proportion of total patent applications will be largely led by domestic filers and, notably, foreign filers, albeit a very small contributor, are also predicted to increasingly add to this trend by filing more utility models than invention patents as a proportion of their total patent filings. A comparison of projections in Chart 4 above to Chart 7 below shows the share of domestic utility model filings to total patent filings in 2015 will increase from their share in 2011 (by 2 percentage points, to 40% from 38%), and also the share of domestic invention patent filings in 2015 will increase from their share in 2011 (by 2 percentage points, to 30% from 28%). (The share of domestic design patent filings in 2105 will fall from their share in 2011 by 4 percentage points, to 30% from 34%.) A comparison of Chart 5 above and Chart 8 below shows that foreign contributions to utility model filings as a percentage of all patent applications in 2015 will increase from their rate in 2011 (by 2 percentage points, to 5% from 3%), and foreign filings of invention patents as a share of total foreign patent filings will actually fall (1 percentage point, to 85% from 86%). (Foreign filings of design patents as a share of total foreign patent filings will fall by 1 percentage point, to 10% from 11%.)

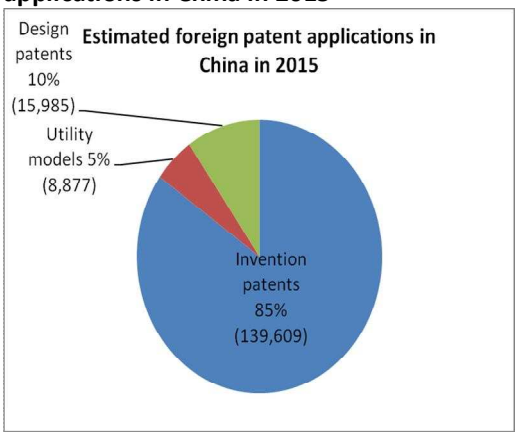
By way of summarising the key trends herein, on one hand, invention patent filings by domestic filers are projected to increase as a percentage of total domestic filings, yet on the other hand utility model filings by domestic filers as a share of total filings will simultaneously increase and exceed invention patent filings. Also, utility model filings by foreigners are projected to increase as a share of their total patent filings and their invention patent filings as a share of their total filings will actually marginally decrease.

Chart 7: Estimated* domestic patent applications in China in 2015



Source: *Methodology Approach A discussed in the "Chapter 1" section in the Annex

Chart 8: Estimated* foreign patent applications in China in 2015



Source: *Methodological Approach A discussed in the "Chapter 1" section in the Annex

Judging from the above figures, while it seems China is commendably on track to meet and very likely exceed major government-set targets for overall patent growth by 2015, it also appears these targets will be met due to a disproportionate growth in utility model applications compared with growth in invention patent (and design patent) applications. 2015 is used as a projection year given it is specifically mentioned as the year by which the main targets in the *NPDS*, and a variety of different provincial/municipal 12th Five Year IP Plans and IP Strategies, are set.[20] For example, the *NPDS*, issued in November 2010, sets the goal for 2 million annual patent filings in China by 2015. (See Chapter 2 and the "Chapter 2" section in the Annex for detailed information on government-set patent targets.) While it is quite possible the figures presented in the above Charts 6 – 8 are an upper bound, and although calculated based upon past growth rates with all else constant, they are useful to at least generally show that unmitigated there will very likely be some potentially concerning trends in the composition of China's future patent growth. The projections reflect that not only is China in recent years witnessing a disproportionately small filing of highest-quality patents, but in the near future may very well see this imbalance rise even more. It also should not be ruled out that, at worst, this increased filing of less-than-highest-quality patents may include a concerning rise in low-quality patents. (See the "Chapter 1" section in the Annex for a full description of methodology employed for the calculations used for Charts 6-8, as well as other estimates not presented in this section using different methodological approaches.)

Ⅲ.1.1.1.4 Core measures of patent quality

Patents granted

Many patents in China never make it past the application stage given high rates of withdrawal and invalidation. Gao et. al (2011) finds that during a 10 year period of time reviewed, 50% of the invention applications filed in China by domestic Chinese applicants were withdrawn.[21] In 2010, SIPO received 391,177 invention patent applications, whereas 29,448 invention applications were

[20] Also it is used as it represents the patent filing situation in the near-future although not too distant future (whereas estimating patent composition in the too distant future would face even more estimation uncertainties).
[21] Gao et al. (2011), p. 20

rejected and 75,949 were withdrawn (105,397 between the two, i.e. about 27% of total applications).[22]

In terms of breakdowns among foreign vs. domestic filers, while previously noted that there have been more domestic applications for invention patents in China than foreign ones since 2003, it in fact was not until six years later, in 2009, that invention patents granted to domestic entities outnumbered patents granted to foreign entities. And this was the first time this occurred since 1989.[23] Further statistical breakdown on numbers of invention patents, utility models, and design patents that are granted from 2006-2011 can be found in the "Chapter 1" section in the Annex.

Looking at a more narrow and recent sample (from 2006-2010), one finds, albeit using a rough proxy-based methodology, that 45% of all patent applications in China are ultimately "not granted" (this term is used hereafter subject to qualifications mentioned in the methodology explained in the "Chapter 1" section in the Annex). Of these patents not ultimately granted, invention patents have the highest rate of not being granted (67%), followed by design patents (38%) and utility models (25%).[24] Herein while the high rates of not granting invention patents seems intuitively explained given the higher thresholds required for qualifying for such protection, it is notable that design patents, which do not bear similarly high thresholds to invention patents and in fact have relatively low thresholds, are still granted at notably higher rates than utility models in China.

For context, within the same sample period (2006-2010), China appears to experience roughly similar rates of ultimately not granting invention patents and utility model patents applications when compared to several sample countries in the EU which are known to be innovative. Using the same methodology mentioned (see the "Chapter 1" section in the Annex), China's 67% rate of not granting invention patents is higher than that of Austria (52%), but lower than that of Denmark (89%) and Germany (72%). China's 25% rate of not granting utility model patents is higher than Germany (15%) and Austria (23%), but not Denmark (26%).

Patents invalidated

Judging from readily available statistics, China has patent invalidations rates at the same level or perhaps even lower than well developed countries, although it is worth noting that these figures are sometimes debated. SIPO's 2010 Annual Report suggests that in 2010 the PRB received 2,411 invalidation requests, whereas 21.1% were for invention patents, 47.6% were for utility models (over twice as many as for invention patents), and 31.3% were for design patents.[25] This translates into a miniscule number of patent invalidation requests let alone resulting invalidations as a percentage of patents that are granted on a yearly basis. The accuracy of these numbers are sometimes questioned.[26] In the EU, it appears that in 2009 less than 5% of patents filed with the EPO were invalidated.[27] And in the earlier part of this decade at least, less than 4% of patents in Japan, which has a utility model and invention patent system, were invalidated.[28] For context, the rates of

[22] Note 1: 12,299 of these filers filed for re-examination. Note: in 2010, 721,753 invention patents were granted, and 564,760 were in-force. (Source: Data from Gao et al. (2011); SIPO statistics.)
[23] Gao et al. (2011), pp 18-19
[24] Note: It should be kept in mind that if a utility model or design patent in China is not granted it is simply because its application is missing some administrative-related components, whereas utility model and design patents do not undergo a Substantive Examination for first approval (like invention patents) as to the merits of their inventiveness and novelty.
[25] SIPO (2010) *Annual Report: Chapter IV: Patent Application and Examination,* p 48 http://english.sipo.gov.cn/laws/annualreports/2010/201104/P020110420372588586402.pdf
[26] 2012, June 15- Consultations with a patent attorney based in the US
[27] Wilding, J. (2010). *Statistics for EPO oppositions and appeals – Update*. HLBBshaw Ltd. (p. 1) Retrieved from http://www.hlbbshaw.com/uploads/files/20100716115959_8523.pdf
[28] Sun, H. (2004). Post-grant patent invalidation in China and in the United States, Europe, and Japan: A Comparative Study. *Fordham Intellectual Property, Media and Entertainment Law Journal*.

subsequently upholding patent validation after an invalidation claim appear to be roughly similar for both the EPO and China's PRB, at around 30% of cases.[29]

Still, and importantly, it is likely that if China's patent enforcement system were improved to be more effective these patent invalidation rates would be higher. For example, if the system were improved in terms of allowing a more appropriate number of pieces of *prior art* to be admissible in invalidation proceedings utility model invalidation rates in particular would likely be higher (see Chapter 4 for more details). This reflects that the scale of China's patent quality problem is larger than that reflected by current invalidation rates alone.

"Patents in-force" and related life-span of patents

Another metric of the quality of the patent ecosystem in China is the rate of "patents in-force," i.e. those that are granted and valid in China. This is one useful metric of the value of patents as it measures patents that have not been invalidated or abandoned by the owner and thus are ostensibly serving some commercial or other use.

There were a large number of patents in-force in China in 2010. Out of 2,216,082 patents in-force in 2010, 82.4% were owned by domestic filers and 17.6% were owned by foreign filers.[30] Sources tout that 46.4% of Chinese invention patents last over five years,[31] contributing to the aforementioned patent in-force indicator.[32]

Despite the aforementioned findings, patents in China, particularly those owned by domestic entities, are only maintained for a relatively short amount of time. Gao et al. (2011), reviewing recent statistical trends, find that the average life-span for invention patents awarded to domestic Chinese entities is only 5 years, whereas it is 9 years for foreign-owned invention patents in China.[33] Other data shows that as of 2010 only 4.6% of invention patents in China were maintained for more than 10 years. The typical life-span of utility models owned by Chinese patentees was between 2-4 years, and those owned by foreign patentees was between 2-7 years. The life-span of design patents owned by Chinese patentees was between 1-4 years, and 2-7 years for those owned by foreign patentees.[34]

By way of one comparison, the life-spans of invention patents in China are substantially less than the average life of an equivalent patent in various developed countries sampled for this study. For example, the median life-span of patents in the US is around 12 years.[35] A review of the life-span of

[29] Widing (2010), p. 1; and China Law & Science Group (2011) "Characteristics and practices of [sic] utility model system in China." p. 12. Note 1: the 30% figure applies to invention patents as well as utility models. Note 2: China Law & Science Group (2011) finds from 2000-2008, the PRB in China *partially* invalidated less than 12% of utility model patents and less than 17% of invention patents in invalidation claims. Note 2: It is not fully clear from all the statistics in these sources if they incorporate invalidated patents that were subsequently re-examined and as a result then maintained.

[30] China Patent Agent (H.K.) Ltd. Newsletter 2011 Issue 2 (2011), p. 2

[31] SIPO: quality, not numbers, key to patents and innovation. (2011, January 5). *China Daily*. Retrieved from http://www.chinadaily.com.cn/cndy/2011-01/05/content_11794970.htm

[32] Note: In 2010, among invention patents filed by Chinese entities, enterprises accounted for 50% of invention patents in-force, research institutes accounted for 9%, universities accounted for 21% (thus 30% for research institutes and universities combined), individuals accounted for 19%, and other "organisations" accounted for 1% of invention patents in-force. (Source: Gao et al. [2011], pp 34-35)

[33] Gao et al. (2011), pp 86-87

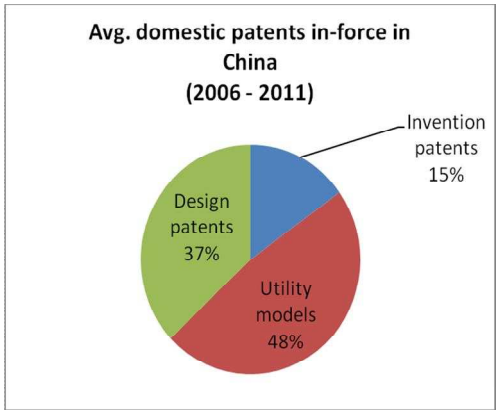
[34] *Statistics on valid patents in China by 2010*. (2011, April 25). China Science Patent & Trademark Agent Ltd. [CSPTAL] Newsletter, pp. 3-4. Retrieved from http://www.csptal.com/upload/CSPTAL%20newsletter%20on%20valid%20patent%20201104%20en.pdf

[35] Sherman, E. (2009). Patent life spans shorter than law allows. *CBS News*. Retrieved from http://www.cbsnews.com/8301-505124_162-43440508/patent-life-spans-shorter-than-law-allows/. Note: it should of course be considered that some patents may be maintained more for litigation purposes than for 'innovation purposes.'

patents by Danguy and Van Pottelsberghe (2009) shows that German patents typically have a life-span of a bit over 12 years, and the typical life-span of Japanese patents is around 17 years.[36] Life-spans of patents granted by the patent office in Finland in recent years are over 11 years.[37] While a number of factors not necessarily related to patent quality partially explain these trends, the figures still likely indicate the number of quality and highest-quality patents in China is, on average, comparatively lower than in these countries.

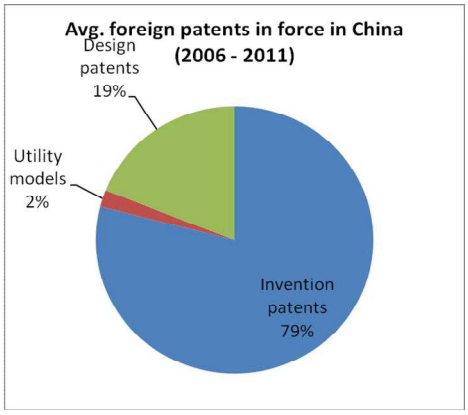
Further, it is strikingly clear that foreigners hold an exponentially higher ratio of invention patents in-force than domestic entities as a proportion of their individual filings, and Chinese entities hold an exponentially higher ratio of utility models and design patents in-force than foreign entities. As illustrated in Chart 9 below, between 2006-2011, out of all patents in-force owned by domestic entities, 85% were not invention patents (i.e. 48% were utility models and 37% were design patents), whereas only 15% of patents in-force owned by domestic entities were invention patents. In contrast, as illustrated in Chart 10 below, during the same time period, out of all foreign patents in-force in China, 79% were for invention patents and only 21% were for utility models (2%) and design patents (19%).[38] These numbers show low rates of invention patents in-force held by domestic filers, who make up the vast majority of patent holdings in China, which additionally confirms that despite China's patent filing explosion many patents filed in China are likely of less-than-highest-quality.

Chart 9: Domestic patents-in force in China (Avg. 2006-2011)



Source: SIPO statistics; calculations

Chart 10: Foreign patents in-force in China (Avg. 2006-2011)



Source: SIPO statistics; calculations

This said, for context, it is worth noting that there has been a recent uptick in the number of invention patents in-force out of total patents in-force owned by domestic entities.[39] Specifically, domestic entities owned slightly more than 50% of all invention patents in-force in 2011, a change from the past trend of foreign enterprises owning more (see the "Chapter 1" section in the Annex for related statistics).

[36] Danguy, J., & Pottelsberghe, B. V. (2009). Cost-benefit analysis of the community patent. *Bruegel Working Paper*, p. 11, Appendix B, Table C in Appendix. Retrieved from http://www.bruegel.org/publications/publication-detail/publication/366-cost-benefit-analysis-of-the-community-patent/

[37] *Annual statistics on patent applications and patents.* (2012).National Board of Patents and Registration of Finland. Retrieved from http://www.prh.fi/en/patentit/Tilastoja/vuositilastot.html

[38] Calculations (data source: Gao et al. (2011), p. 30)

[39] This might suggest raising patent quality of patents owned by domestic entities in China, or could just be a natural product of more invention patents being owned by domestic entities and a relative fall in growth rates of new invention patents being filed by foreign applicants.

Patents filed solely for patent litigation/malicious prosecution actions

Some patents serve as tools for "malicious prosecution actions," those with the sole purpose of being used to litigate and, in doing so, harm another entity. Some sources go as far as to suggest that more than 50% of the patents filed with SIPO "are of foreign innovations with the sole intention of suing the same for patent infringement." [40] It is worth noting that given utility models are cheaper and easier to obtain than invention patents, it theoretically makes the most sense for applicants to apply for these types of patents if they indeed intend to utilise their patents for the sole purpose of malicious prosecution actions. While in the absence of a detailed analysis of patent litigation (which is difficult in the first place given lack of publication of many patent cases) it is not possible to determine to what extent this phenomenon is playing out, it nonetheless warrants that close attention is paid to the intentions of utility model filers in China.[41] (See Chapter 4 for a further discussion herein.)

Patent citations

The frequency of patent citations in patent application literature and also in non-patent application literature can be used as a gauge of the significance of a patent and thus its quality. The idea is that particularly significant patented inventions will be cited more often in patent documents, which must disclose all relevant *prior art*, than less significant patents.

As mentioned in the Introduction section, the OECD sets forth a Patent Quality Index that focuses heavily on patent citations, and this index ranks China quite low. According to the 2011 index, China's performance from 2000-2010 is ranked below the world average. It is also ranked below the OECD average; below the EU27 average; and as the second lowest out of 25 individual countries highlighted in a report featuring the index, including lower than Brazil (which is a developing country, like China). The index is a composite indicator using six criteria: forward citations (number of citations of a patent); backward citations (number of patents and scientific papers cited by a patent); patent family size (number of countries in which that patent is "taken"); number of claims; "generality index" (dispersion of patent citations over technology classes); and grant lag."[42] (Note: While patent citations are indeed a useful metric for judging patent quality, methodology qualifications should at least be noted to better contextualise the limitations of such metrics.[43])

IPDRC's Patent Strength Ranking for China

In 2012, it was announced that the IPDRC, a non-profit academic research unit under SIPO, released a ranking of national and regional patent strength in China in 2011. The ranking uses criteria of patent creation, "patent application," protection, management, and service. Beijing (1), Shanghai (2), and Guangdong (3) rank in the top three for patent creation; Guangdong (1), Beijing (2) and Jiangsu (3) rank highest in terms of patent application; Guangdong (1), Hunan (2), and Jiangsu (3) rank highest in terms of patent protection; Jiangsu (1), Guangdong (2) and Beijing (3) rank highest in

[40] "China's Innovation Capacities May be Over-hyped" (2011)

[41] Given the different nature of what they protect and the arguably lesser necessity of such models to innovation, this concern may apply less to design patents.

[42] A further methodological description of the index can be found on p. 1 of OECD (2011). Note: the OECD's Patent Quality Index shows an average of a 20% decline from average patent quality across the countries reviewed from 1990-2000 vs. 2000-2010. This reflects a digression in patent quality in the aggregate performance of countries reviewed, although it appears China's performance is only ranked from 2000-2010 (or there is no change in China's performance during those two time periods).

[43] For example, some sources warn of "citation inflation," whereas the propensity to cite patents increases for reasons unrelated to patent quality (Source: Among others, see Marco, A. C. (2006, July 3). *The dynamics of patent citations* (Working Paper). Retrieved from Vassar College, Department of Economics. Web site: http://economics.vassar.edu/docs/working-papers/VCEWP84.pdf

terms of patent management; and Beijing (1), Shanghai (2), and Guangdong (3) rank highest in terms of patent service. Guangdong (1), Beijing (2), and Jiangsu (3) ranked highest overall on the index.[44]

Empirical research on foreign firms' patenting decisions in China

Empirical evidence generally shows that weaknesses in China's IPR institutional and regulatory system, in addition to other factors, deter foreign firms from developing and filing highest-quality patents in China. Hu (2008) finds that strengthening of IPR enforcement in China should lessen risk and lead to an increased propensity of foreign firms to patent in China.[45] Also, Hu (2008) sets out empirical evidence to support the "competitive threat hypothesis," whereby competing imports in China lead foreign industry to increase patent filings in China; however, Hu finds no strong evidence supporting the "market covering hypothesis" that expansion of an industry's own sales in China raises the propensity to file patents. Hu explains the latter situation in that the incentive to seek patent protection may be offset by the market power of the industry that could encourage it to avoid introducing new technologies to China.[46] Hu and Jefferson (2009) find recent surges in patent activity by foreign firms largely take the form of "patenting existing intellectual property that they created elsewhere."[47] Additionally, Hu (2010) also finds that a notable number of foreigners develop and file patents in China in response to technology-proximity-based import competition in China.[48]

Ⅲ.1.1.2 Sub-section 1.2: Other metrics show innovation in China is impressive, but this often deserves better contextualisation

Introduction: This sub-section explores how China measures-up on a number of innovation metrics not exclusively related to patent statistics, finding that China indeed has a growingly impressive innovation potential although in some senses its actual innovation is perhaps overhyped. This sub-section is by no means exhaustive in the innovation metrics it discusses, and is only intended to give a brief snapshot of China's innovation landscape.

[44] SIPO. (2012, June 19). *SIPO issues the report on overall patent strength*. Retrieved from http://english.sipo.gov.cn/news/official/201206/t20120619_711414.html Note: Unfortunately, while some details are available, full details on the methodology and disaggregated indicator scores for the ranking did not appear to be readily publically available during the writing of this study.

[45] Hu, A. G. (2008). *Propensity to patent, competition, and China's foreign patenting surge*. European Policy for Intellectual Property Conference. p. 18. Retrieved from http://www.epip.eu/conferences/epip03/papers/Hu_China_patents_Hu_Sep08.pdf

[46] Ibid, p. 34. Note: Interestingly, Hu (2008) also provides evidence that Chinese firms are more likely to imitate the technology of Japanese, Korean, and Taiwanese firms more so than German and US technology. He explains this may in part be because Chinese firms are more of direct competitors with the aforementioned Asian countries, and at large one might suggest their technology is comparatively "less advanced and fundamental in nature" (p. 23) and thus it is easier for Chinese firms to "absorb" such technology (pp 23-34).

[47] Hu, A. G., & Jefferson, G.(2009). A great wall of patents: What is behind China's recent patent explosion? *Journal of Development Economics*, Vol. 90, No. 1, p. 66 http://faculty.smu.edu/millimet/classes/eco6375/papers/hu%20jefferson.pdf

[48] Hu (2010). Note: Data analysed in this study was from 1995-2004.

Ⅲ.1.1.2.1 Fundamental metrics of innovation outside patent statistics

R&D expenditures

Overview

R&D expenditures are one useful metric of inputs into innovation in China. Battelle (2011) notes that in 2011 China's gross expenditures on R&D (GERD), which include R&D expenditures by government, business, and higher education institutions, amounted to 1.6% of its GDP. These expenditures are predicted to stay at 1.6% of China's GDP in 2012. In 2011, China's total R&D expenditures represented 13.1% of the world total (with Europe representing 24.5% of the total); and in 2012, China's total R&D expenditures are predicted to reach 14.2% of the world's total (whereas Europe's could drop slightly to 24.1%).[49] From 1996-2007, China experienced average annual total R&D growth rates of 22%, the highest in the world.[50] R&D investments in China have grown annually at 12% over the last several years, outpacing annual GDP growth by 2-3%.[51]

Other statistics provide more disaggregated details on the levels of R&D in research collaborations and R&D expenditures by Chinese companies in particular, showing they score relatively impressively on some metrics but lag well behind other countries on others. China has the highest percentage of R&D collaborations (16%) if compared with Japan (7%), India (5%), and South Korea (3%).[52] Still, while China has the largest amount of researchers, in terms of per capita researcher within its labour force it scores far below the world average.[53] As of 2010, there were no Chinese companies among the top 20 global R&D spenders.[54] However, in fairness, Huawei and ZTE, two big Chinese companies, are experiencing some of the fastest R&D growth out of any company in the last decade;[55] and within the top 1,000 R&D spenders in 2009 and among fast growing middle-income countries therein, China clearly leads with the likes of Petro-China Co Ltd., ZTE Corp., China Railway Construction Corp. Ltd., China Petroleum & Chemical Corp., and a laundry list of other Chinese companies.[56]

SOEs in particular

In terms of Chinese SOEs in particular, it could be argued that they do not spend utterly insignificant amounts on R&D, although this amount could certainly be higher particularly given the level of financial and other support they enjoy from the government in an attempt to make them competitive. According to statistics and calculations presented in the "Chapter 1" section in the Annex, out of all medium- and large-sized domestic-funded enterprises in China, Chinese SOEs spent on average 13% of annual R&D expenditures from 2006-2010. During the same time, Chinese SOEs on average employed 15% of the R&D personnel out of all medium- and large-sized domestic-funded enterprises in China. [57] Chinese SOEs' R&D expenditures are not dispersed equally across all SOEs but

[49] Battelle. (2011). *2012 global R&D funding forecast*. R&D Magazine. Retrieved from http://battelle.org/docs/default-document-library/2012_global_forecast.pdf?sfvrsn=2
[50] Ibid, p. 30
[51] Ibid, p. 28
[52] Ibid, p. 31
[53] WIPO (2011), p. 36
[54] Ernst, D. (2011). China's innovation policy is a wake-up call for America. *East-West Centre,* p. 8. Retrieved from http://www.eastwestcenter.org/fileadmin/stored/pdfs/api100.pdf
[55] Ernst (2011), p. 10, endnote 29
[56] WIPO (2011), p. 41
[57] Source: See data in "Chapter 1" section in the Annex. Note that "State-owned Enterprises" are distinguished in National Bureau of Statistics records from "State Joint Ownership Enterprise" and "State-Sole Funded Corporation." Note 2: Statistics only readily available for medium and large-sized enterprises, thus inferably excluding smaller enterprises.

concentrated only in some, whereas, for example, by some estimates, 80% of large Chinese SOEs do not have an R&D team and thus inferably not much R&D expenditure.[58] Generally, according to Chan and Daim (2011), Girma and Gong (2008a), and Girma and Gong (2008b), Chinese SOEs' operations tend to focus on short-term performance rather than risky longer-term investments in R&D and innovative building.[59] Further, Guan et al. (2006) and OECD (2007) find that overall, despite some exceptions, Chinese SOEs are not particularly efficient in knowledge production and utilising R&D to innovate.[60]

Other metrics

Not all companies rely on R&D, neither abroad nor in China, to boost certain types of technological and also non-technological innovation – and so other metrics are needed to measure this innovation. In middle- and low-income countries it is common for enterprises to invest in machinery and equipment rather than R&D *per se* to build up innovation.[61] Process and organisational innovation in the services sector are particularly important forms of non-technological innovation that do not require formal R&D but rather other forms of innovation investment.[62] SMEs in particular may innovate without conducting formal R&D.[63]

Box 4: Distribution of government-sponsored innovation investment

As this section highlights innovation investment metrics, it is also important to mention that not only absolute value of investment is an important metric to gauge innovation, but so is distribution of such investment. Herein China may not measure up as well as perhaps assumed in terms of access to government-sponsored innovation investment in particular. Many Chinese and foreign companies suggest that access to government-sponsored sources of finance is critical in allowing them to boost innovation at large and patent creation and utilisation in particular, and denial of this type of support inferably harms innovation and patent initiatives. For example, survey data from EU companies suggests that outside access to talent, access to public grants, fiscal incentives, and public loans and guarantees are some of the most important factors affecting EU companies' innovation plans and activities.[64] Consultations suggest that access to the aforementioned types of financial support is also a key factor affecting many private Chinese companies' innovation plans and activities.[65] Thus, denial of such support by Chinese funding bodies, which is further discussed in Chapter 3 hereto, hurts innovation at large and building of quality patents in particular.

[58] Roth, E. (2012) PowerPoint Presentation for European Chamber's May 17th 2012 R&D Conference in Shanghai (citing a statement from Liu Yanhua, Vice Minister of MoST)

[59] Chan, L., & and Daim, T. U. (2011). Technology transfer in China: literature review and policy implications. *Journal of Science and Technology Policy in China*, Vol. 2 Issue.2, pp 122 – 145. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1942785&show=html; Girma, S., & Gong, Y. (2008a). FDI, linkages and the efficiency of state-owned enterprises in China. *Journal of Development Studies*, Vol. 44, pp 728-49. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00220380802009233; Girma, S., & Gong, Y. (2008b). Putting people first? Chinese state-owned enterprises' adjustment to globalization. *International Journal of Industrial Organization*, Vol. 26, pp 573-85. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167718707000513

[60] Guan, Y., Mok, C., Yam, R., Chin, K., & Pun, K. (2006). Technology transfer and innovation performance: evidence from Chinese firms. *Technological forecasting and social change*, Volume 73, pp 666-78. Retrieved from http://www.mendeley.com/research/technology-transfer-and-innovation-performance-evidence-from-chinese-firms/; OECD. (2007). *Reviews of innovation policy*. Organisation for Economic Co-operation and Development. Retrieved from http://www.oecd.org/science/innovationinsciencetechnologyandindustry/oecdreviewsofinnovationpolicy.htm

[61] WIPO (2011), p. 42

[62] WIPO (2011), p.34

[63] WIPO (2011), p. 42

[64] European Commission. (2010). *The 2010 EU survey on R&D investment business trends*. Directorate General Research. p. 17 Retrieved from http://iri.jrc.es/research/docs/survey/2010/Survey_2010_final.pdf

[65] 2012, 25 April - Consultations with certain Chinese R&D managers based in Shanghai

Ⅲ.1.1.2.2 Certain trends in innovation in China

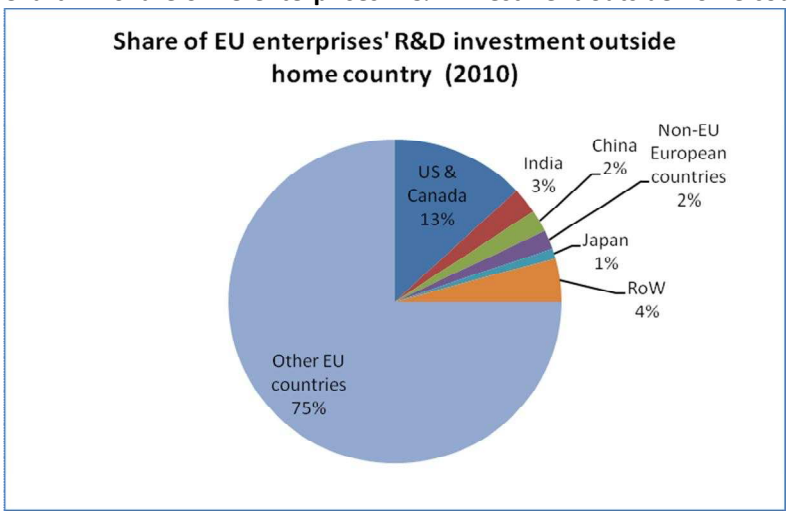
Trends in innovation from foreign entities in China

Innovation spending, development of technology, and tech-transfer

China is becoming an increasingly attractive place for foreign R&D investment. For example, at the end of 2011, there were over 1,400 foreign-invested R&D centres in China, a relatively significant number.[66] In particular, firms from the EU, US, Japan and Korea invest in R&D operations in China.[67]

In terms of EU firms specifically, surveys suggest that when investing outside of their home country, such firms may invest in R&D activities in China. As illustrated in Chart 11 below, a 2010 EC survey finds that the largest share of EU companies' R&D investments *outside* the EU is concentrated in the US and Canada (13%), India (2.6%), China (2.2%), non-EU European countries (1.9%), Japan (1%), and the Rest of the World (RoW) (4%).[68] And India and China will see some of the highest growth rates in new innovation-related investment from European (and US) firms in the near future.[69]

Chart 11: Share of EU enterprises' R&D investment outside home country



Source: Data from European Commission (2010)

Nonetheless, survey data of an aggregated sample of representatives from a range of industries suggests outsourcing of R&D to China is typically not a particularly significant innovation activity for the sampled EU companies at present, and the absolute amount of these investments is still relatively low. Specifically, the aforementioned 2010 EC survey finds that "*outsourcing R&D is overall the least relevant activity for innovation*" among the EU firms surveyed, which include those from high R&D-intensity, medium R&D-intensity, and low R&D-intensity firms.[70] Further, this R&D investment in China in particular, while rising in growth terms from around 1% in 2005[71] is not insignificant it is still a meager 2% of the average global R&D expenditures of EU firms surveyed. Also,

[66] Liu, Y. (2011, December 9). Greater convenience for foreign investors. *China Daily*. Retrieved from http://www.chinadaily.com.cn/business/10thWTO/2011-12/09/content_14240801.htm

[67] Among others see: Serger, S. *Foreign R&D centres in China: development, drivers, spillovers*. Swedish Institute for Growth Policy Studies. University of Lund. [Presentation]. Retrieved from http://www.oecd.org/dataoecd/18/16/39244157.pdf

[68] European Commission (2010), p. 5

[69] European Commission. (2009). *The 2009 EU survey on R&D investment business trends*. Directorate General Research. Figure 9, p. 20. Retrieved from http://iri.jrc.ec.europa.eu/research/docs/survey/2009/JRC60580.pdf; European Commission (2010), p. 21; and Battelle (2011), p. 27

[70] European Commission (2010), p. 5

[71] European Commission (2009), p. 20

on average, surveyed EU firms' R&D investment in China is not projected to rise by more than 3% (to about 5% of total R&D expenditures) in 2013.[72]

Also, survey data shows that China is not receiving particularly significant amounts of non-R&D innovation-related investment from EU firms. European Commission (2010) measures EU-based companies' investments in "knowledge sharing activities" (collaboration, outsourcing and licensing activities)[73] with public and private partners outside their home country and specifically finds the highest concentration of such investments in the US and Canada (14%), RoW (6%), non-EU European countries (4%), and lastly, in China, India, and Japan (roughly 2% each).[74]

Further, academic studies suggest foreign enterprises do not develop breakthrough patented technologies in China given concerns over the IPR environment. Bruun and Bennett (2002) find that foreign companies are particularly concerned about losing the technical lead to China in high-tech sectors through misappropriation or leakage of IPR, which, despite the fact that there may be common interests for cooperation with Chinese entities in the near-term, leads them to be reluctant to develop advanced innovation operations in China. This generally leads companies to keep their core R&D in headquarters or other more IPR-friendly areas, and to disperse their R&D activities in China in order to reduce risks created by IPR infringement of any one unit. Exacerbating this concern is the general lack of transparency in the Chinese legal system.[75] Wu and Pangarkar (2006), who investigated a sample of listed Chinese firms, find that FDI tends to favour low-tech industries in China, and this trend has only slowly changed recently whereas high-tech sectors still particularly lag in S&T development.[76] Asakawa and Som (2008) note that while many foreign companies are keen to expand research operations in China, in practice they have been reluctant to do so due to IPR concerns.[77] Chan et al. (2011) raise issues similar to those in the aforementioned studies.[78] Other studies also reflect these type of concerns, for example, an older study finds that foreign companies transfer technologies to China that are at least five years behind global standards or transfer technologies that would be obsolete in the near future unless certain means can be utilised to protect the technology particularly well.[79]

Given the above findings – as well as those from Hu (2008), Hu and Jefferson (2009), and Hu (2010) mentioned previously – as an aggregate it appears that foreign entities, despite having some of the highest-quality patents in the world, purposefully do not as a first priority develop breakthrough

[72] European Commission (2010), p. 13
[73] European Commission (2010), p. 20
[74] European Commission (2010), p. 6. Note: With the exception of such investments in the US and Canada, these investments in the other mentioned countries are predicted to increase (p. 21)
[75] Bruun, P., & Bennett, D. (2002). Transfer of technology to China: a Scandinavian and European perspective. *European Management Journal*, Vol. 20, pp 98-106. Retrieved from http://www.sciencedirect.com/science/article/pii/S0263237301001189
[76] Wu, J., & Pangarkar, N. (2006). Rising to the global challenge: strategies for firms in emerging markets. *Long Range Planning*, Vol. 39, pp 295-313. Retrieved from http://people.bath.ac.uk/mnsipc/Reading/Asian%20corporations/Chinese%20articles/local%20strat.pdf
[77] Asakawa, K., & Som, A. (2008). Internationalization of R&D in China and India: conventional wisdom versus reality. *Asia Pacific Journal of Management*, Vol. 25, pp 375-94. http://www.springerlink.com/content/77648375721p2u28/
[78] Chan and Daim (2011), pp 122 – 145
[79] For example, see Maskus et al. (1998), the authors of which interviewed managers of a range of foreign enterprises operating in China, who noted they at large do not develop breakthrough technologies in China given concerns over misappropriation of IP and patent infringements. Almost all respondents reported that they transferred technologies that were at least five years behind global standards, or transferred technologies that would be obsolete in the near future, unless certain means could be utilised to protect the technology particularly well. Additionally, concern over weak patent protection in China prevented foreign enterprises from fully integrating their Chinese operations, whereas they typically divided production processes among production sites to avoid revealing the full nature of their operations in any one site. (Source: Maskus, K. E., Dougherty, S. M., & Mertha, A. (1998, September). *Intellectual property rights and economic development in China*.)

patented products in China for either the Chinese or foreign markets. This is largely due to perceived weak IPR protection in China, in addition to foreign firms having strong market power.

Additionally, although it deserves to be tested through a fuller investigation of its own, it is the opinion of this study that foreign firms may be particularly reluctant to develop breakthrough patented products in China given the magnitude of the threat of Chinese entities to use illegally acquired IPR from foreign firms to very seriously jepoardise their business operations not just in China but also abroad. Specifically, foreign firms may be reluctant to develop such products in China given concerns over perceived weakness in IPR protection are magnified by the very real possibility that IPR could fall into the hands of a Chinese entity that is able to produce the IPR-protected products and through economies of scale only afforded in China and/or preferential government support very seriously threaten the IPR owners' business operations not just in China but also abroad. This magnitude of this threat arguably exists in China to an extent unparalleled by that associated with other developing countries that have IPR regimes also perceived to be weak.

Still, these findings should be taken in context, as depending on industry and firm there are likely a variety of exceptions to these findings. The promise of tens or hundreds of millions of customers clearly does attract a large number of foreign business operations to China, some of which are undeniably innovating to some extent. There are certain industries, for example the pharmaceutical industry, for which these trends may not play out as described in the aggregated survey data, and may in fact play out in the opposite manner. There are high-tech transfers from foreign companies to operations in China, even if at large these are not of the most breakthrough of such technologies. Also, many of the aforementioned studies do not appear to specifically address introduction of non-technological innovations, which are important forms of innovation in China.

Trends in innovation from Chinese entities

From one standpoint, Chinese entities are admirably becoming more innovative. It is undeniable that China has dramatically improved its innovation capacity over the years, importantly led by a growing number of domestic firms that are well-regarded for being innovative in their own right. Many Chinese companies have innovation-related strengths that many EU companies do not even have in terms of the ability to make quick decisions without going through lengthy internal processes/discussions and the ability to very quickly commercialise products and services and adjust them subsequently to the particular tastes of the Chinese market.[80] Generally, China is adept at incremental innovation.[81]

From a comparative standpoint, however, Chinese enterprises at large are likely not yet as competitive in innovation as their foreign counterparts. The 2012 China Innovation Survey in Booz & Co. et al. (2011), which surveys foreign and Chinese executives in China, shows that over 50% of respondents felt Chinese companies were less innovative than their foreign competitors.[82] Much more could be said of and many tools could be used to further analyse the innovation capacity of domestic entities in China although an exhaustive analysis herein is beyond the scope of this study.

[80] 2012, May 15 - Consultations with members of the European Chamber in Shanghai

[81] Testimony of Dan Breznitz to the US-China Economic and Security Review Commission. (2012, May 10). p. 7. Retrieved from http://www.uscc.gov/hearings/2012hearings/written_testimonies/12_5_10/breznitz.pdf

[82] Booz and Company (2012, June 7). 2012 China Innovation Survey: Innovation- China's next advantage? *Booz & Company Inc.* p. 2. Retrieved from http://www.booz.com/cn/home/41992563/41993453/50636275

Trends in innovation from foreign entities in China and domestic Chinese entities

Some sources tout that China's innovative potential is relatively high. For example, a variety of news sources, including Reuters and Forbes, have run the headline that China is a global leader in innovation.[83]

Also, from one perspective, China scores well on academic rankings for innovation. A 2011 report by the Chinese Academy of Science and Technology for Development (CASTED) found China to rank 21st in terms of innovative abilities amongst the world's top 40 most innovation economies.[84] The World Economic Forum's 2011 Global Competitiveness ranks China 31st out of 142 countries on the composite "Innovation and sophistication factors" indicator, therein scoring 37th on "Business sophistication" and 29th on "Innovation" whereas the latter score is led by good performance on the sub-indicator of "government procurement of advanced technological products," followed by indicators like "innovation capacity."[85] INSEAD et al. (2011) Global Innovation Index 2011 ranks China 29th globally in terms of its innovation capacity.[86]

Still, from another perspective, China has a notable way to go in becoming innovative. For example, despite the aforementioned high scores on China's innovation capacity, it is striking to note that China ranks a very low 100 out of 142 countries, including some of most underdeveloped countries in the world, on the World Economic Forum's 2011 Global Competitiveness sub-indicator for "Availability of the latest technologies." And in the same report China ranks 77th on the composite "Technological readiness" indicator and 61st on the "Firm-level technology absorption" sub-indicator.[87] More importantly, to put all the innovation rankings mentioned in the above paragraph in better context, these studies suggest there are at least 20 highly competitive countries at present that are more innovative than China, which, from one point of view at least, is in fact a sizeable number. Additionally, some sources, for example Vaitheeswaran (2012), find that while China does well in certain types of innovation, its innovation capacity is in fact typical of developing economies seeking to catch up with innovative developed countries, and it overall fairs poorly on an important aspect of innovation: using new thinking to create market value.[88] Much more could be said of and many tools used to further analyse China's innovation capacity; however, an exhaustive analysis herein is beyond the scope of this study. Nonetheless, collectively, the findings mentioned thus far in this study clearly show that China indeed has a growingly impressive innovation potential, although in some sense its actual innovation at present is overhyped.

---

[83] Among others see: Chesbrough, H. (2010, November 11). China, innovation superpower: How to deal with it. *Forbes*. Retrieved from http://www.forbes.com/2010/11/11/china-innovation-globalization-leadership-managing-strategy.html; China the next leader in innovation. (2010, December 7). *The News International*. Retrieved from http://www.thenews.com.pk/article-6709-China-the-next-leader-in-innovation; and China Poised to Become a Global Innovation Leader. (2010, October 6). *Thomas Reuters.* Press Release. Retrieved from http://thomsonreuters.com/content/press_room/legal/626670

[84] China ranks 21st on its own global innovation list. (2011, February 2). *China Daily*. http://www.chinadaily.com.cn/china/2011-02/25/content_12075099.htm

[85] World Economic Forum (2011). *Global competitiveness report 2011-2012*, p. 149 www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf

[86] INSEAD, Alcatel- Lucent, Booz and Company, Confederation of Indian Industry, & WIPO. (2011). *The global innovation index 2011: Accelerating growth and development*, p. xviii. Retrieved from http://www.globalinnovationindex.org/gii/main/previous/2010-11/FullReport_10-11.pdf

[87] World Economic Forum. (2011). *Global competitiveness report 2011-2012*, pp 148-149. Retrieved from www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf

[88] Vaitheeswaran, V. V. (2012). *Need, speed, and greed: How the new rules of innovation can transform businesses, propel nations to greatness, and tame the world's most wicked problems*. New York, NY. Harper Collins.

Ⅲ.1.2 Summary

Analysis of a variety of patent statistics suggests that China's progress in patent quality lags behind rates of patent filings. There are higher ratios of domestic to foreign filings of invention patents in EU countries sampled than in China. There are significantly lower average life-spans of Chinese patents and lower percentages of patents in-force owned by domestic filers vs. foreign filers in China compared with the rates in EU countries sampled; higher rates of utility model invalidations than invention patent and design patent invalidations; concerning rates of patents filed solely for malicious prosecution actions, which may be made up more so of utility models than other types of patents; poor scores in terms of patent citations; and empirical econometric analyses generally shows foreign enterprises at large do not typically file patents on breakthrough inventions in China. In effect, the analysis confirms that China indeed has a patent quality problem as certain scholars and industry experts, as well as Chinese government officials in meetings with the European Chamber and otherwise, have suspected.

In addition, there is reason for concern when looking ahead at the possibility that China's patent ecosystem may be less composed of highest-quality patents than perhaps envisaged. For example, this study's projections indicate that, all else constant, there might be over 2.6 million less-than-highest-quality patents (utility models and design patents) filed in China in 2015 alone, which would be substantially more than the estimated filings of highest-quality patents in that year. Of note, it is projected there might be 39% more (over 430,000) total utility model applications than total invention patent applications filed in China in 2015, which is 28 percentage points more than the comparison rate between the two in 2011. The year 2015 is significant because major Chinese policies set it as the year by which their patent targets are to be realised.

In terms of its innovation capacity at large, metrics suggests that China indeed has a growingly impressive innovation potential, although in some sense its actual innovation is overhyped. For example, China does not attract EU innovation spending on a scale as perhaps otherwise suspected; and, despite some exceptions, empirical evidence suggests foreign firms at large avoid developing or transferring breakthrough technology, and filing patents on such technology, in China. There are reports of concerning distribution of government-sponsored innovation investment, which can drag down innovation; and evidence that Chinese SOEs, in which many innovation hopes are invested, typically lag on a variety of innovation metrics. Further, even the most positive rankings show there are at least 20 highly competitive countries that are more innovative than China at present, which, from one point of view at least, is in fact a sizeable number.

Given these findings, the question then becomes what unaddressed patent-related policies and practices in China hamper it from better building patent quality and innovation, and which of these might be able to be practically solved in the near-term. These issues are explored in Chapters 2-4 of this study.

Ⅵ References

2012, 25 April - Consultations with certain Chinese R&D managers based in Shanghai
2012, June 15- Consultations with a patent attorney based in the US
2012, May 15 - Consultations with members of the European Chamber in Shanghai
Annual statistics on patent applications and patents. (2012).National Board of Patents and Registration of Finland. Retrieved from http://www.prh.fi/en/patentit/Tilastoja/vuositilastot.html
Asakawa, K., & Som, A. (2008). Internationalization of R&D in China and India: conventional wisdom versus reality. Asia Pacific Journal of Management, Vol. 25, http://www.springerlink.com/content/77648375721p2u28/
Battelle. (2011). 2012 global R&D funding forecast. R&D Magazine. Retrieved from http://battelle.org/docs/default-document-library/2012_global_forecast.pdf?sfvrsn=2
Booz and Company (2012, June 7). 2012 China Innovation Survey: Innovation- China's next advantage? Booz & Company Inc. Retrieved from http://www.booz.com/cn/home/41992563/41993453/50636275
Bruun, P., & Bennett, D. (2002). Transfer of technology to China: a Scandinavian and European perspective. European Management Journal, Vol. 20, pp 98-106. Retrieved from http://www.sciencedirect.com/science/article/pii/S0263237301001189
Chan, L., & and Daim, T. U. (2011). Technology transfer in China: literature review and policy implications. Journal of Science and Technology Policy in China, Vol. 2 Issue.2, pp 122 – 145. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1942785&show=html
Chesbrough, H. (2010, November 11). China, innovation superpower: How to deal with it. *Forbes*. Retrieved from http://www.forbes.com/2010/11/11/china-innovation-globalization-leadership-managing-strategy.html
China IPR (2012, April 5). China boasts sharpest growth in PCT applications. Retrieved from http://www.chinaipr.gov.cn/newsarticle/news/government/201204/1287307_1.html
China Patent Agent (H.K.) Ltd. Newsletter 2011 Issue 2 (2011)
China Poised to Become a Global Innovation Leader. (2010, October 6). Thomas Reuters. Press Release. Retrieved from http://thomsonreuters.com/content/press_room/legal/626670
China ranks 21st on its own global innovation list. (2011, February 2). China Daily. http://www.chinadaily.com.cn/china/2011-02/25/content_12075099.htm
China the next leader in innovation. (2010, December 7). The News International. Retrieved from http://www.thenews.com.pk/article-6709-China-the-next-leader-in-innovation
China's innovation capacities may be over-hyped. (2011, August 7). International Business Times. Retrieved from http://www.ibtimes.com/articles/193820/20110807/china-innovation-railway-patent-education-system-academic-fraud.htm
Danguy, J., & Pottelsberghe, B. V. (2009). Cost-benefit analysis of the community patent. Bruegel Working Paper, p. 11, Appendix B, Table C in Appendix. Retrieved from http://www.bruegel.org/publications/publication-detail/publication/366-cost-benefit-analysis-of-the-community-patent/
Ernst, D. (2011). China's innovation policy is a wake-up call for America. East-West Centre. Retrieved from http://www.eastwestcenter.org/fileadmin/stored/pdfs/api100.pdf
European Commission. (2009). The 2009 EU survey on R&D investment business trends. Directorate General Research. Retrieved from http://iri.jrc.ec.europa.eu/research/docs/survey/2009/JRC60580.pdf

European Commission. (2010). The 2010 EU survey on R&D investment business trends. Directorate General Research. Retrieved from http://iri.jrc.es/research/docs/survey/2010/Survey_2010_final.pdf
Gao, L., Li, M., Cheng, Y. et al. (2011, September). *Report on the quality for invention in China*. Beijing Intellectual Property Rights Institute.
Girma, S., & Gong, Y. (2008a). FDI, linkages and the efficiency of state-owned enterprises in China. Journal of Development Studies, Vol. 44, pp 728-49. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00220380802009233
Girma, S., & Gong, Y. (2008b). Putting people first? Chinese state-owned enterprises' adjustment to globalization. International Journal of Industrial Organization, Vol. 26, pp 573-85. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167718707000513
Hlbbshaw Law http://www.hlbbshaw.com/uploads/files/20100716115959_8523.pdf
Hu, A. G. (2008). Propensity to patent, competition, and China's foreign patenting surge. European Policy for Intellectual Property Conference. Retrieved from http://www.epip.eu/conferences/epip03/papers/Hu_China_patents_Hu_Sep08.pdf
Hu, A. G. (2010). Propensity to patent, competition and China's foreign patenting surge. Research Policy, Vol. 39, Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733310001101
Hu, A. G., & Jefferson, G.(2009). A great wall of patents: What is behind China's recent patent explosion? Journal of Development Economics, Vol. 90, No. 1, http://faculty.smu.edu/millimet/classes/eco6375/papers/hu%20jefferson.pdf
Hu, M. C., & Mathews, J. A. (2008). China's national innovative capacity. Research Policy, Volume. 37. Retrieved from http://nthur.lib.nthu.edu.tw/handle/987654321/61675
INSEAD, Alcatel- Lucent, Booz and Company, Confederation of Indian Industry, & WIPO. (2011). The global innovation index 2011: Accelerating growth and development, p. xviii. Retrieved from http://www.globalinnovationindex.org/gii/main/previous/2010-11/FullReport_10-11.pdf
Lee, C. Y. (2011, December 21). China tops US, Japan to become top patent filer. Reuters. Retrieved from http://www.reuters.com/article/2011/12/21/us-china-patents-idUSTRE7BK0LQ20111221
Liu, Y. (2011, December 9). Greater convenience for foreign investors. China Daily. Retrieved from http://www.chinadaily.com.cn/business/10thWTO/2011-12/09/content_14240801.htm
Marco, A. C. (2006, July 3). The dynamics of patent citations (Working Paper). Retrieved from Vassar College, Department of Economics. Web site: http://economics.vassar.edu/docs/working-papers/VCEWP84.pdf
Maskus, K. E., Dougherty, S. M., & Mertha, A. (1998, September). *Intellectual property rights and economic development in China*
OECD. (2011b). OECD Science, Technology and Industry Scoreboard 2011. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/sti_scoreboard-2011-en
Roth, E. (2012) PowerPoint Presentation for European Chamber's May 17th 2012 R&D Conference in Shanghai
Serger, S. Foreign R&D centres in China: development, drivers, spillovers. Swedish Institute for Growth Policy Studies. University of Lund. [Presentation]. Retrieved from http://www.oecd.org/dataoecd/18/16/39244157.pdf
Sherman, E. (2009). Patent life spans shorter than law allows. CBS News. Retrieved from http://www.cbsnews.com/8301-505124_162-43440508/patent-life-spans-shorter-than-law-allows/
SIPO (2010) Annual Report: Chapter IV: Patent Application and Examination http://english.sipo.gov.cn/laws/annualreports/2010/201104/P020110420372588586402.pdf
SIPO (2011) http://english.sipo.gov.cn/statistics/szslzljb/201101/t20110125_570591.html
SIPO. (2012, June 19). SIPO issues the report on overall patent strength. Retrieved from http://english.sipo.gov.cn/news/official/201206/t20120619_711414.html

SIPO: quality, not numbers, key to patents and innovation. (2011, January 5). China Daily. Retrieved from http://www.chinadaily.com.cn/cndy/2011-01/05/content_11794970.htm
SIPO. (2011, January 25). Grants for three kinds of patents received from home and abroad (January 2010-December. 2010). A SIPO Statistics. Retrieved from http://english.sipo.gov.cn/statistics/gnwsqnb/2010/201101/t20110125_570600.html
Statistics on valid patents in China by 2010. (2011, April 25). China Science Patent & Trademark Agent Ltd. [CSPTAL] Newsletter, pp. 3-4. Retrieved from http://www.csptal.com/upload/CSPTAL%20newsletter%20on%20valid%20patent%20201104%20en.pdf
Stembridge, B. (2011). Chinese patenting: Report on the current state of innovation in China. Thomson Reuters. Retrieved from http://ip.thomsonreuters.com/
Sun, H. (2004). Post-grant patent invalidation in China and in the United States, Europe, and Japan: A Comparative Study. *Fordham Intellectual Property, Media and Entertainment Law Journal*.
Testimony of Dan Breznitz to the US-China Economic and Security Review Commission. (2012, May 10). Retrieved from http://www.uscc.gov/hearings/2012hearings/written_testimonies/12_5_10/breznitz.pdf
Vaitheeswaran, V. V. (2012). *Need, speed, and greed: How the new rules of innovation can transform businesses, propel nations to greatness, and tame the world's most wicked problems*. New York, NY. Harper Collins.
Wilding, J. (2010). *Statistics for EPO oppositions and appeals – Update*. HLBBshaw Ltd. Retrieved from
WIPO. (2011). World Intellectual Property Report. Retrieved from http://www.wipo.int/freepublications/en/intproperty/944/wipo_pub_944_2011.pdf
WIPO. (2012, March 5). International patent filings set new record in 2011. Retrieved from http://www.wipo.int/pressroom/en/articles/2012/article_0001.html
WIPO. (2012, March 5). International Patent Filings Set New Record in 2011. Retrieved from http://www.wipo.int/pressroom/en/articles/2012/article_0001.html
World Economic Forum. (2011). Global competitiveness report 2011-2012. Retrieved from www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf
Wu, J., & Pangarkar, N. (2006). Rising to the global challenge: strategies for firms in emerging markets. Long Range Planning, Vol. 39, Retrieved from http://people.bath.ac.uk/mnsipc/Reading/Asian%20corporations/Chinese%20articles/local%20strat.pdf
Zheng, L., & Lan, X. (2009). A tale of two cities: A comparison of patent-based innovative performance of domestic and multinational companies in China. Proceedings of the Joint Symposium of US-China Advanced Technology Trade and Industrial Development. Journal of International Commerce & Economics, Retrieved from http://www.usitc.gov/journals/entire_journal_2010_11_4.pdf

Ⅶ Annexes[89]

Chapter 1

Ⅶ.1.1 Select patent application statistics for China

Table 17: Invention patent applications in China (1996-2011), by filer, with ratios

Year	Domestic	Foreign	Total	Ratio domestic to foreign*	Ratio domestic apps. to total*	Ratio foreign apps. to total*
1996	11,471	17,046	28,517	0.7 : 1	0.4 : 1	0.6 : 1
1997	12,713	20,953	33,666	0.6 : 1	0.4 : 1	0.6 : 1
1998	13,726	22,234	35,960	0.6 : 1	0.4 : 1	0.6 : 1
1999	15,596	21,098	36,694	0.7 : 1	0.4 : 1	0.6 : 1
2000	25,346	26,401	51,747	1 : 1	0.5 : 1	0.5 : 1
2001	30,038	33,166	63,204	0.9 : 1	0.5 : 1	0.5 : 1
2002	39,806	40,426	80,232	1 : 1	0.5 : 1	0.5 : 1
2003	56,769	48,549	105,318	1.2 : 1	0.5 : 1	0.5 : 1
2004	65,786	64,347	130,133	1 : 1	0.5 : 1	0.5 : 1
2005	93,485	79,842	173,327	1.2 : 1	0.5 : 1	0.5 : 1
2006	122,318	88,172	210,490	1.4 : 1	0.6 : 1	0.4 : 1
2007	153,060	92,101	245,161	1.7 : 1	0.6 : 1	0.4 : 1
2008	194,579	95,259	289,838	2 : 1	0.7 : 1	0.3 : 1
2009	229,096	85,477	314,573	2.7 : 1	0.7 : 1	0.3 : 1
2010	293,066	98,111	391,177	3 : 1	0.7 : 1	0.3 : 1
2011	415,829	110,583	526,412	3.8 : 1	0.8 : 1	0.2 : 1

Source: SIPO statistics database; calculations.*Ratios are approximations.

Table 18: Utility model applications in China (1996-2011), by filer, with ratios

Year	Domestic	Foreign	Total	Ratio domestic to foreign*	Ratio domestic apps. to total *	Ratio foreign apps. to total *
1996	49,341	263	49,604	188 : 1	1 : 1	0 : 1
1997	49,902	227	50,129	220 : 1	1 : 1	0 : 1
1998	51,220	177	51,397	289 : 1	1 : 1	0 : 1
1999	57,214	278	57,492	206 : 1	1 : 1	0 : 1
2000	68,461	354	68,815	193 : 1	1 : 1	0 : 1
2001	79,275	447	79,722	177 : 1	1 : 1	0 : 1

[89] Special thanks to both Ruben Moen, Working Group Assistant at the European Chamber, for his help in compiling some of the statistics in this Annex.

2002	92,166	973	93,139	95 : 1	1 : 1	0 : 1
2003	107,842	1,273	109,115	85 : 1	1 : 1	0 : 1
2004	111,578	1,247	112,825	89 : 1	1 : 1	0 : 1
2005	138,085	1,481	139,566	93 : 1	1 : 1	0 : 1
2006	159,997	1,369	161,366	117 : 1	1 : 1	0 : 1
2007	179,999	1,325	181,324	136 : 1	1 : 1	0 : 1
2008	223,945	1,641	225,586	136: 1	1 : 1	0 : 1
2009	308,861	1,910	310,771	162 : 1	1 : 1	0 : 1
2010	407,238	2,598	409,836	157 : 1	1 : 1	0 : 1
2011	581,303	4,164	585,467	140 : 1	1 : 1	0 : 1

Source: SIPO statistics database; calculations.*Ratios are approximations.

Table 19: Design patent applications in China (1996-2011), by filer with ratios

Year	**Domestic**	**Foreign**	**Total**	**Ratio domestic to foreign***	**Ratio domestic apps. to total***	**Ratio foreign apps. to total ***
1996	21,395	3,219	24,614	6.6 : 1	0.9 : 1	0.1 : 1
1997	27,456	2,957	30,413	9.3 : 1	0.9 : 1	0.1 : 1
1998	31,287	3,345	34,632	9.4 : 1	0.9 : 1	0.1 : 1
1999	37,148	2,905	40,053	12.8 : 1	0.9 : 1	0.1 : 1
2000	46,532	3,588	50,120	13 : 1	0.9 : 1	0.1 : 1
2001	56,460	4,187	60,647	13.5 : 1	0.9 : 1	0.1 : 1
2002	73,572	5,688	79,260	12.9 : 1	0.9 : 1	0.1 : 1
2003	86,627	7,427	94,054	11.7 : 1	0.9 : 1	0.1 : 1
2004	101,579	9,270	110,849	11 : 1	0.9 : 1	0.1 : 1
2005	151,587	11,784	163,371	12.9 : 1	0.9 : 1	0.1 : 1
2006	188,027	13,295	201,322	14.1 : 1	0.9 : 1	0.1 : 1
2007	253,675	13,993	267,668	18.1 : 1	0.9 : 1	0.1 : 1
2008	298,620	14,284	312,904	20.9 : 1	1 : 1	0 : 1
2009	339,654	11,688	351,342	29.1 : 1	1 : 1	0 : 1
2010	409,124	12,149	421,273	33.6 : 1	1 : 1	0 : 1
2011	507,538	13,930	521,468	36.4 : 1	1 : 1	0 : 1

Source: SIPO statistics database; calculations.*Ratios are approximations.

Ⅶ.1.2 Growth rates for patent applications in China (average annual growth rate)

Table 20: Invention patent applications: AAGR (%) of domestic and foreign applications

Year	**AAGR domestic apps.**	**AAGR foreign apps.**	**AAGR domestic + foreign apps.**
1997	11	23	18
1998	8	6	7
1999	14	-5	2
2000	63	25	41

2001	19	26	22
Total (%)	**23**	**15**	**18**
2002	33	22	27
2003	43	20	31
2004	16	33	24
2005	42	24	33
2006	31	10	21
Total (%)	**33**	**22**	**27**
2007	25	5	17
2008	27	3	18
2009	18	-10	9
2010	28	15	24
2011	42	13	35
Total (%)	**28**	**5**	**21**

Source: SIPO statistics database; calculations. Percentages are rounded.

Table 21: Utility model applications: AAGR (%) of domestic and foreign applications

Year	AAGR domestic apps.	AAGR foreign apps.	AAGR domestic + foreign apps.
1997	1	-14	1
1998	3	-22	3
1999	12	57	12
2000	20	27	20
2001	16	26	16
Total (%)	**10**	**15**	**10**
2002	16	118	17
2003	17	31	17
2004	4	-2	3
2005	24	19	24
2006	16	-8	16
Total (%)	**15**	**32**	**15**
2007	13	-3	12
2008	24	24	24
2009	38	16	38
2010	32	36	32
2011	43	60	43
Total (%)	**30**	**27**	**30**

Source: SIPO statistics database; calculations. Percentages are rounded.

Table 22: Design patent applications: AAGR (%) of domestic and foreign applications

Year	AAGR domestic apps.	AAGR foreign apps.	AAGR domestic + foreign apps.
1997	28	-8	24
1998	14	13	14

1999	19	-13	16
2000	25	24	25
2001	21	17	21
Total (%)	**21**	**7**	**20**
2002	30	36	31
2003	17	31	19
2004	17	25	18
2005	49	27	47
2006	24	13	23
Total (%)	**27**	**26**	**28***
2007	35	5	33
2008	18	2	17
2009	14	-18	1
2010	21	4	20
2011	24	15	24
Total (%)	**22**	**2**	**19**

Source: SIPO statistics database; calculations. Percentages are rounded. *Reminder: number due to rounding.

Ⅶ.1.3 Select patent filing statistics for select EU countries

Table 23: Germany: Patents - types and filers, ratios ('96 – '98)

Country	Year	Invention Patent (Domestic)	Invention Patent (Foreign)	*Ratio* (Invention Patent Domestic vs. Foreign)*	Total Invention Patent (Domestic + Foreign)	*Ratio* (Total [F+D] Invention Patents vs. Total Utility Models)*
Germany	1996	42,322	9,511	4.4:1	51,833	1996 - 2.3:1 1997 - 2.4:1 1998- 2.5:1
	1997	44,438	11,291	3.9:1	55,729	
	1998	46,523	10,843	4.3:1	57,366	
	Year	Utility Model (Domestic)	Utility Model (Foreign)	*Ratio* (Utility Model Domestic vs. Foreign)*	Total Utility Model (Domestic + Foreign)	
	1996	19,697	2,579	7.6:1	22,276	
	1997	20,152	2,910	6.9:1	23,062	
	1998	19,887	2,654	7.5:1	22,541	

Source: WIPO statistics database; calculations.*Ratios are approximations

Table 24: Germany: Patents - types and filers, ratios ('08 – '10)

Country	Year	Invention Patent (Domestic)	Invention Patent (Foreign)	*Ratio* (Invention Patent Domestic vs. Foreign)*	Total Invention Patent (Domestic + Foreign)	*Ratio* (Total [F+D] Invention Patents vs. Total Utility Models)*
Germany	2008	49,240	13,177	3.7 : 1	62,417	2008 - 3.7:1 2009 - 3.4:1 2010 - 3.5:1
	2009	47,859	11,724	4.1 : 1	59,583	
	2010	47,047	12,198	3.9 : 1	59,245	
	Year	Utility Model (Domestic)	Utility Model (Foreign)	*Ratio*(Utility model Domestic vs. Foreign)*	Total Utility Model (Domestic + Foreign)	
	2008	14,047	3,020	4.7 : 1	17,067	
	2009	14,242	3,064	4.7 : 1	17,306	
	2010	13,694	3,311	4.1 : 1	17,005	

Source: WIPO statistics database; calculations.*Ratios are approximations

Table 25: Denmark: Patents – types and filers, ratios ('08 – '10)

Country	Year	Invention Patent (Domestic)	Invention Patent (Foreign)	*Ratio*(Invention Patent Domestic vs. Foreign)*	Total Invention Patent (Domestic + Foreign)	*Ratio* (Total [F+D] Invention Patents vs. Total Utility Models)*
Denmark	2008	1,634	195	8.4 : 1	1,829	2008 - 7.6:1 2009 - 8.0:1 2010 - 7.5:1
	2009	1,518	131	11.6 : 1	1,649	
	2010	1,626	142	11.5 : 1	1,768	
	Year	**Utility Model (Domestic)**	**Utility Model (Foreign)**	***Ratio* (Utility Model Domestic vs. Foreign)***	**Total Utility Model (Domestic + Foreign)**	
	2008	218	23	9.5 : 1	241	
	2009	181	26	7 : 1	207	
	2010	198	37	5.4 : 1	235	

Source: WIPO statistics database; calculations.*Ratios are approximations

Table 26: Austria: Patents – types and filers, ratios ('08 – '10)

Country	Year	Invention Patent (Domestic)	Invention Patent (Foreign)	*Ratio*(Invention Patent Domestic vs. Foreign)*	Total Invention Patent (Domestic + Foreign)	*Ratio* (Total [F+D] Invention Patents vs. Total Utility Models)*
Austria	2008	2,298	329	7 : 1	2,627	2008 - 3.1:1 2009 - 2.8:1 2010 - 3.0:1
	2009	2,263	292	7.8 : 1	2,555	
	2010	2,424	249	9.7 : 1	2,673	
	Year	**Utility Model (Domestic)**	**Utility Model (Foreign)**	***Ratio* (Utility Model Domestic vs. Foreign)***	**Total Utility Model (Domestic +Foreign)**	
	2008	682	179	3.8 : 1	861	
	2009	717	209	3.4 : 1	926	
	2010	678	204	3.3 : 1	882	

Source: WIPO statistics database; calculations.*Ratios are approximations

Table 27: Industrial design for selected countries

Country	Year	Industrial Design (Domestic)	Industrial Design (Foreign)	Via The Hague	Total
Germany	2008	5,025	677	239	5,941
	2009	5,220	540	140	5,900
	2010	5,553	588	144	6,285
Austria	2008	805	227	-	1,032
	2009	629	87	-	716
	2010	694	288	-	982
Denmark	2008	183	65	-	248
	2009	172	26	12	210
	2010	162	27	21	210

Source: WIPO statistics database; calculations.*Ratios are approximations

Note on data sources in Tables 23 - 27: Intellectual property data cited in above charts in this annex are taken from the WIPO Statistics Database, which is primarily based on information provided to WIPO by national/regional IP offices and data compiled by WIPO during the application process of international filings through the PCT, the Madrid System, and the Hague System. Those statistics only cover patents filed in the domestic patent applications offices of the countries listed. They do not necessarily cover patent applications filed by residents of those countries with the EPO.

Table 28: EPO filing data 2002-2011 per country of residence of the applicant

Country/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Austria	1,151	1,240	1,327	1,459	1,564	1,784	1,797	1,940	2,218	2,351
China	1,137	1,455	1,881	2,687	4,213	5,835	6,490	8,270	12,750	16,946
Denmark	1,173	1,295	1,375	1,567	1,627	1,759	2,080	2,044	2,156	2,236
Germany	26,507	27,211	28,227	29,152	30,670	32,128	33,405	30,486	33,146	33,181

Source: EPO statistics

Ⅶ.1.4 Patent applications by entities' registration status

Table 29: Invention patent applications by entities' registration status (large- and medium-sized enterprises only*) (2006-2010)

Registration Status	2010	2009	2008	2007	2006	Sum
	Invention patent apps.	Invention patent apps.	Invention patent apps.	Invention patent apps.	Invention patent apps.	
Total	**72,523**	**63,230**	**43,773**	**36,074**	**25,685**	**241,285**
Domestic Funded Enterprises	**49,909**	**45,694**	**33,507**	**27,741**	**19,000**	**175,851**
State-owned Enterprises	5,280	4,285	2,951	1,921	1,488	15,925
Collective-owned Enterprises	738	669	698	680	549	3,334
Cooperative Enterprises	231	153	86	72	91	633
Joint Ownership Enterprises	21	17	12	45	19	114
State Joint Ownership Enterprises	6	10	6	38	9	69
Limited Liability Corporations	17,000	16,487	13,986	9,605	9,690	66,768
State Sole Funded Corporations	2,644	2,163	1,635	1,305	1,130	8,877
Share-holding Corporations Ltd.	17,915	17,588	11,540	13,073	5,257	65,373
Private Enterprises	8,659	6,343	4,177	2,312	1,885	23,376
Other Enterprises	65	152	57	33	21	328
Enterprises with Funds from Hong Kong,Macao, Taiwan	**7,245**	**6,171**	**4,332**	**3,299**	**3,425**	**24,472**
Joint-venture Enterprises	3,521	2,489	1,724	972	933	9,639
Cooperative Enterprises	83	57	26	53	481	700
Enterprises with Sole Fund	3,220	3,203	2,305	2,039	1,823	12,590
Share-holding Corporations Ltd.	421	422	277	235	188	1,543
Foreign Funded Enterprises	**15,369**	**11,365**	**5,934**	**5,034**	**3,260**	**40,962**
Joint-venture Enterprises	4,787	4,227	3,369	2,346	1,679	16,408
Cooperation Enterprises	59	70	29	148	31	337
Enterprises with Sole Fund	10,001	6,567	2,148	2,247	1,341	22,304

Share-holding Corporations Ltd.	522	501	388	293	209	1,913

Source: China Statistical Yearbook, National Bureau of Statistics; calculations. * Data only available for large- and medium-sized enterprises, thus inferably excludes smaller enterprises.

Table 30: Patent filings by domestic Chinese entities' registration status (large- and medium sized enterprises only*) (2009)

Chinese Domestic-Funded Enterprises	Total patent apps.	Patent apps per entity as % of total applications of all large and medium sized entities	Invention apps.	Invention apps per entity % of total invention apps.	Utility and design patent apps.	Utility and design apps per entity % of total utility and design apps.	Utility and design patents as % of each entities' total apps.
State-owned Enterprises	12,135	10%	4,285	9%	7,850	10%	65%
Collective-owned Enterprises	1,411	1%	669	1%	742	1%	53%
Cooperative Enterprises	573	0%	153	0%	420	0%	73%
Joint Ownership Enterprises	99	0%	17	0%	82	0%	83%
State Joint Ownership Enterprises	72	0%	10	0%	62	0%	86%
Limited Liability Corporations	39,642	31%	16,487	34%	23,155	31%	58%
State Sole Funded Corporations	6,754	5%	2,163	5%	4,591	5%	68%
Share-holding Corporations Ltd.	36,400	29%	17,588	37%	18,812	29%	52%
Private Enterprises	29,398	23%	6,343	13%	23,055	23%	78%
Other Enterprises	648	1%	152	0%	496	1%	77%
TOTAL	127,132	100%	47,867	100%	79,265	100%	62%

Source: China Statistical Yearbook, National Bureau of Statistics, calculations. Note 1: Due to data limitations, 2009 selected as a proxy year, as all data is at least available for that year. Note 2: SOEs are distinguished from "state-joint ownership enterprises, "state sole funded enterprises," and it is not obvious from the statistics which, if any, other corporations are controlled by the state in terms of 50/50 ownership or majority ownership). *Note 3: Data only available for large- and medium-sized enterprises, thus inferably excludes smaller enterprises.

Ⅶ.1.5 Rates of patent applications "not granted" (by type, by country)

Methodology

A proxy-based approach was taken to measure the average rates of patents not being granted relative to average patent application rates. The yearly number of each type of patent applications minus the yearly number of each type of patents granted was used to create that year's patents applied for but "not granted" figure for each type of patent. This was then taken as a percentage of each type of patents' applications for that year. This was taken over the period of 2006-2011 (for Chart 12 below), and from 2006-2010 for Charts 13 and 14 below (whereas 2011 was not included in the latter two charts given the lack of data for some countries reviewed). Then, the average of the averages for these years was taken to create one time period average. For simplicity/readability the study presents the aforementioned figures as rates of patents "not granted."

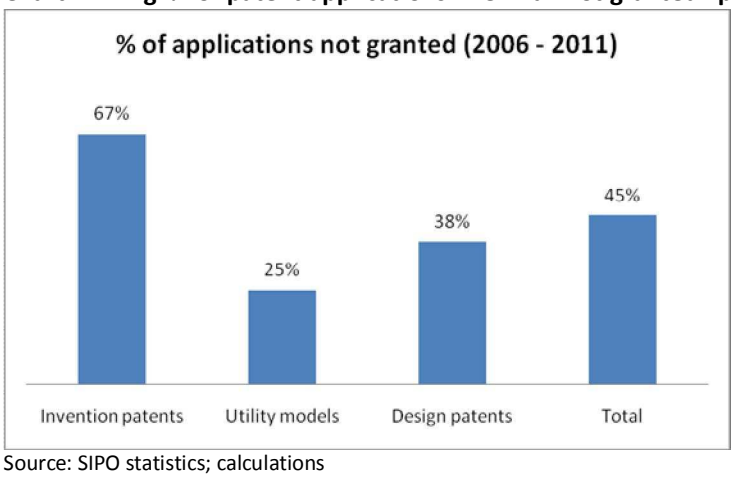
It should be recognised that this methodology is only intended to *very roughly* estimate the average rates of patents "not granted" because it has notable limitations. The methodology does not measure the *actual* rate of patents for which an application is filed but is ultimately not granted. This is because a patent can be filed in year X but not granted in that year but instead in year Y; this is particularly the case for invention patents given the length of their review procedure, but could apply to certain design patent and utility model filings depending on the timing of their review. As such, the figures below are inevitably skewed, although it is uncertain to what extent or direction. Also, for context, it is worth recalling the discussion in Chapter 2 of this study that there are many reasons why a patent application may ultimately not turn into a granted patent.[90] Additionally, it should be noted that the data used for the European countries sampled is from filings at domestic patent offices not EPO filings.[91]

[90] Note 1: As explained in Chapter 2, a patent can be filed although the application or other fees are not paid and so the patent will not be granted; many patents are abandoned somewhere in the application process, e.g. a significant amount of invention patents are abandoned before the Substantive Examination phase as their filers realise they are based on unviable products or processes; patents can be denied for any number of reasons during the application process prior to registration; and utility models and invention patents applications can be filed on the same solution, one can obtain the utility model first, and then when/if awarded the invention patent can abandon the utility model for the invention patent (this last phenomenon does not necessarily skew the "not granted" calculations discussed hereto).
Note 2: It should be kept in mind that if a utility model or design patent is not granted in China it is simply because its application is missing some administration components, whereas utility model and design patents do not undergo a Substantive Examination like invention patents as to the merits of their inventiveness and novelty.

[91] The figures are exclusively representative of the aforementioned European countries' patent filings in their own country's patent offices, not at the EPO. It is worth noting that filers originating in those countries can and certainly do file notable amounts of patents with the EPO.

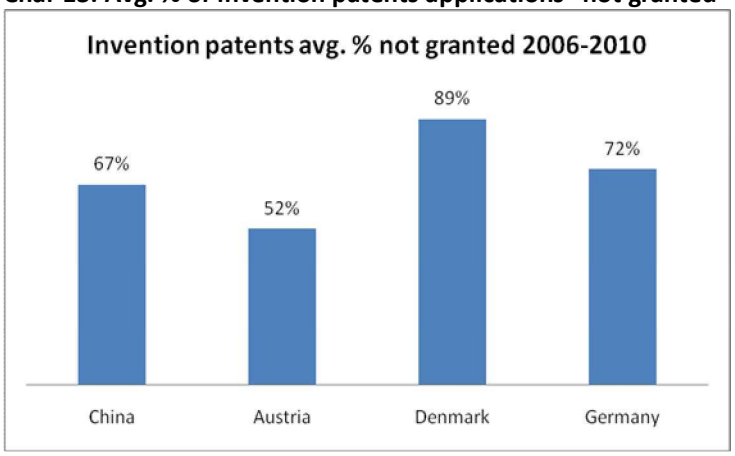
Figures

Chart 12: Avg. % of patent applications in China "not granted" per year (2006-2011)



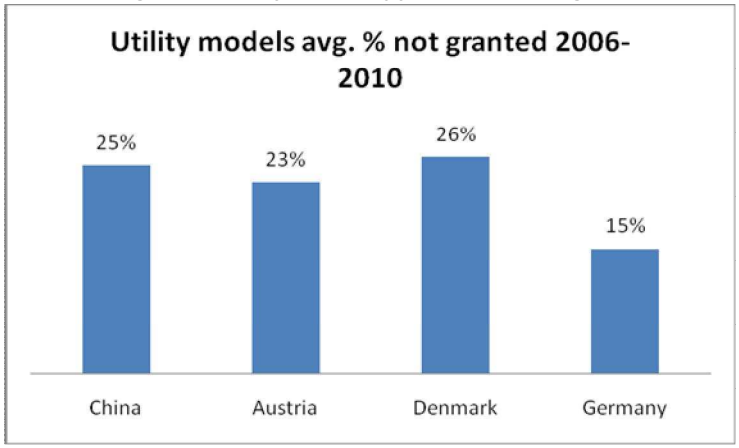
Source: SIPO statistics; calculations

Char 13: Avg. % of invention patents applications "not granted" 2006-2010, by select countries



Source: WIPO and SIPO statistics; calculations. Note: Data was not available from the WIPO source used for Austria's 2008 rates of invention patent filings and granting rates, so the grant reflects its average for 2006-2007 plus 2009-2010.

Char 14: Avg. % of utility model applications "not granted" 2006-2010, by select countries



Source: WIPO and SIPO statistics; calculations

Ⅶ.1.6 Methodology for estimating patent filings in 2015 (by type)

Approach A

The estimates presented in Charts 6 - 8 are based on SIPO data presented earlier in this Annex and calculations using the following functions:

$$Uapp_{2015} = Uapp_{2011} X (1 + AGR_{tu\alpha})^n$$

$$Dapp_{2015} = Dapp_{2011} X (1 + AGR_{td\alpha})^n$$

$$Iapp_{2015} = Iapp_{2011} X (1 + AGR_{ti\alpha})^n$$

Whereas:

- Uapp = utility model applications
- Dapp = design patent applications
- Iapp = invention patent applications
- app_{2011}= number of applications in 2011
- app_{2015} = predicted number of applications in 2015
- $AGR_{tu\alpha}$= avg. growth rate of total (foreign + domestic) utility model applications in time period (2009-2011)
- $AGR_{td\alpha}$= avg. growth rate of total (foreign + domestic) design patent applications in time period (2009-2011)
- $AGR_{ti\alpha}$= avg. growth rate of total (foreign + domestic) invention patent applications in time period (2009-2011)
- n = number of years from 2011-2015

These patent filing estimates were then presented in chart form, and the according percentage of total patent applications was calculated.

"Upper bound" estimates: The average growth rate from 2009-2011 (i.e. growth 2009 to 2010, and 2010 to 2011) of patent applications for each of the types of patents was used in the projections. This rate was used given it is taken from the most recent few years, and thus arguably is the most representative and factual indicator of patent growth in the near future. A longer period of time, for example from 2006-2011 was not used given this period would include patent filings in the middle of the global financial crisis, which may have at least some impact that would cause skewing of the estimates (although using figures from 2009 onwards admittedly does not completely avoid shocks of the financial crisis).

It is possible that using the growth rate from 2009-2011 will result in an upper bound estimate in patent growth given the particularly high rates of application growth in those years, which may or may not necessarily be sustained; however, even when using the compound annual growth rate over five years (see Approach B below), the results are similar. In general, given the continuous growth of total patent applications in China over the last decade, it appears reasonable to use a sampling of recent growth rates to at least roughly predict future patent application growth in China.

Approach B

"Lower bound" estimates: An alternative "lower bound" estimate is provided herein as a way of providing another approach to estimating the composition of patents in China in 2015 that might at least avoid some of the 'over-estimating' possible in the aforementioned upper bound estimates. The lower bound estimate is built upon a very similar approach to the upper bound estimate with some small modifications, namely (1) that the compound annual growth rate (CAGR) is used instead of the AGR, and (2) different years are used to calculate this rate. The functions for this approach are as follows:

$$Uapp_{2015} = Uapp_{2011} X (1 + CAGR_{tu\alpha})^n$$

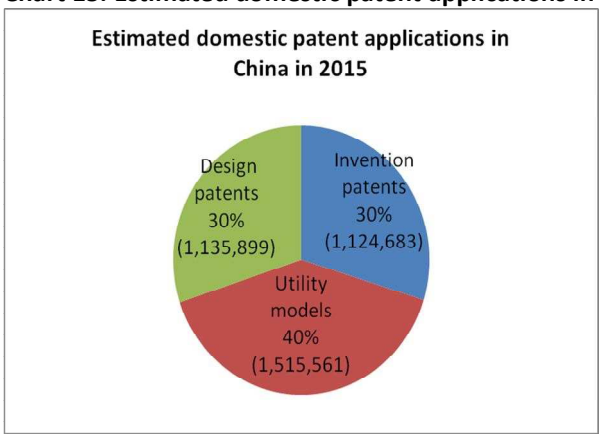
$$Dapp_{2015} = Dapp_{2011} X (1 + CAGR_{td\alpha})^n$$

$$Iapp_{2015} = Iapp_{2011} X (1 + CAGR_{ti\alpha})^n$$

- $CAGR_{tu\alpha}$= CAGR of total (foreign + domestic) utility model applications in time period (2006-2011)
- $CAGR_{td\alpha}$= CAGR of total (foreign + domestic) design patent applications in time period (2006-2011)
- $CAGR_{ti\alpha}$= CAGR of total (foreign + domestic) invention patent applications in time period (2006-2011)

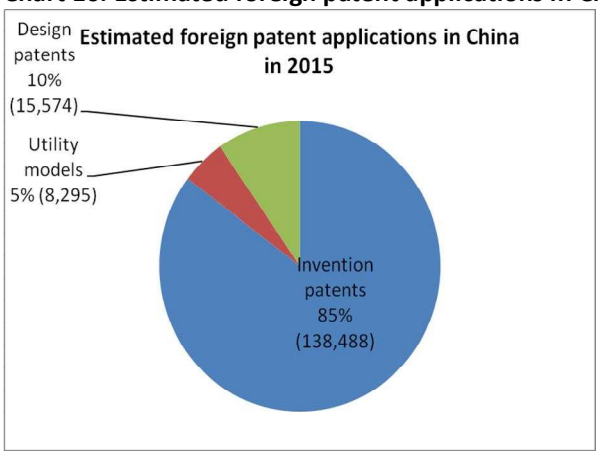
The results from this approach are illustrated below. They differ, but not dramatically, from the "upper bound" results.

Chart 15: Estimated domestic patent applications in China in 2015



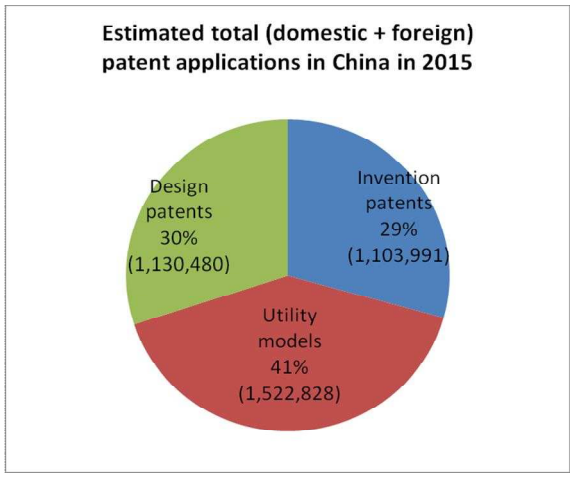
Source: Methodological Approach B

Chart 16: Estimated foreign patent applications in China in 2015



Source: Methodological Approach B

Chart 17: Estimated total (foreign + domestic) patent applications in China in 2015



Source: Methodological Approach B

Additional notes

As mentioned in the body of this study, both methodologies presented herein face limitations in their projection capacity. First, they are built upon a necessary assumption of holding all else constant, whereas this obviously does not account for dynamic effects that take place in the real economy. Second, they are based upon past growth rates, which obviously may change in the future given any number of factors.

Ⅶ.1.7 Rates of patents granted and not granted in China (2006-2011)

Table 31: Number of total patents granted in China, by type (2006-2011)

Year	**Invention patents**	**Utility models**	**Design patents**	**All applications**
2006	57,786	107,655	102,561	268,002
2007	67,948	150,036	133,798	351,782
2008	93,706	176,675	141,601	411,982
2009	128,489	203,802	249,701	581,992
2010	135,110	344,472	335,243	814,825
2011	172,113	408,110	380,290	960,513

Source: SIPO statistics

Table 32: % of patent applications in China not granted (2006-2011)

Year	**Invention patents**	**Utility models**	**Design patents**	**% of all apps. not granted**
2006	73	33	49	53
2007	72	17	50	49
2008	68	22	55	50
2009	59	34	29	40
2010	65	16	20	33
2011	67	30	27	41
Avg.	**67**	**25**	**38**	**45**

Source: SIPO statistics; calculation

Ⅶ.1.8 Patents in-force in China (2006-2011)

Table 33: Foreign patents in-force by type

	Total patents	**Invention patents**	**Utility models**	**Design patents**
2006	178,467	145,981	4,291	28,195
2007	227,634	176,239	4,779	46,616
2008	271,399	209,619	6,387	55,393
2009	326,913	257,994	7,013	61,906
2010	390,679	306,867	8,514	75,298
2011	436,891	345,651	10,638	80,602

Source: SIPO statistics

Table 34: Domestic patents in-force by type

	Total patents	Invention patents	Utility models	Design patents
2006	548,758	72,941	288,032	187,785
2007	622,409	95,678	294,463	232,268
2008	923,797	127,596	463,342	332,859
2009	1,193,110	180,042	558,791	454,277
2010	1,825,403	257,893	849,454	718,056
2011	2,383,617	351,288	1,109,958	922,371

Source: SIPO statistics

Ⅶ.1.9 R&D expenditures by entities' registration status (large- and medium-sized enterprises)

Table 35: R&D expenditures by entities' registration status (large- and medium-sized enterprises*) (2006-2010)

Registration Status	2010 Expenditure on R&D (10,000 yuan)	2009 Expenditure on R&D (10,000 yuan)	2008 Expenditure on R&D (10,000 yuan)	2007 Expenditure on R&D (10,000 yuan)	2006 Expenditure on R&D (10,000 yuan)	Avg annual exp. 2006-2010 (10,000 yuan)
Total	**40,153,965**	**32,115,692**	**26,813,110**	**21,124,561**	**16,301,909**	**27,301,847**
Domestic Funded Enterprises	**29,671,163**	**23,449,930**	**19,520,725**	**14,972,444**	**11,857,649**	**19,894,382**
State-owned Enterprises	3,922,823	3,222,891	2,691,952	1,820,905	1,649,808	2,661,676
Collective-owned Enterprises	463,524	436,754	386,658	390,744	382,390	412,014
Cooperative Enterprises	209,568	96,938	107,765	113,940	62,517	118,146
Joint Ownership Enterprises	82,453	73,116	109,447	118,524	137,099	104,128
State Joint Ownership Enterprises	73,863	66,431	107,211	110,254	130,032	97,558
Limited Liability Corporations	13,533,642	10,793,313	8,734,622	7,095,938	5,648,069	9,161,117
State Sole Funded Corporations	3,696,351	3,111,622	2,363,456	2,501,971	1,945,024	2,723,685
Share-holding Corporations Ltd.	7,269,785	5,510,394	5,070,523	3,777,023	2,916,028	4,908,750
Private Enterprises	4,124,654	3,218,079	2,339,685	1,476,612	1,052,648	2,442,336
Other Enterprises	64,714	98,446	80,075	178,758	9,090	86,217
Enterprises with Funds from Hong Kong,	**3,574,987**	**3,123,358**	**2,235,951**	**1,833,414**	**1,456,934**	**2,444,929**

Macao & Taiwan						
Joint-venture Enterprises	1,479,475	1,433,202	987,193	766,590	560,266	1,045,345
Cooperative Enterprises	44,994	37,646	14,817	38,314	36,221	34,398
Enterprises with Sole Fund	1,595,856	1,424,288	1,022,192	809,004	700,728	1,110,414
Share-holding Corporations Ltd.	454,662	228,222	211,750	219,506	159,719	254,772
Foreign Funded Enterprises	**6,907,815**	**5,542,403**	**5,056,433**	**4,318,703**	**2,987,327**	**4,962,536**
Joint-venture Enterprises	3,582,738	2,909,361	2,966,218	2,363,226	1,498,878	2,664,084
Cooperation Enterprises	81,526	57,509	25,508	51,672	23,088	47,861
Enterprises with Sole Fund	2,652,860	2,031,581	1,649,379	1,467,684	1,096,495	1,779,600
Share-holding Corporations Ltd.	590,692	543,952	415,328	436,121	368,866	470,992

Source*:* China Statistical Yearbook, National Bureau of Statistics; calculations.*Note: Data only available for large- and medium-sized enterprises, thus excludes smaller enterprises.

Ⅶ.1.10 Number of R&D personnel in entities in China by registration status (large and medium-sized enterprises)

Table 36: Number of R&D personnel in entities in China by registration status (large and medium-sized enterprises*) (2006-2010)

Registration Status	Equivalent of R&D Personnel (man-year)					Avg. number of R&D personnel employed (annually (2006-2010)
	2010	2009	2008	2007	2006	
Total	**1,369,908**	**1,306,179**	**1,014,223**	**857,650**	**695,668**	**1,048,726**
Domestic Funded Enterprises	**970,605**	**952,103**	**767,296**	**657,374**	**553,558**	**780,187**
State-owned Enterprises	138,539	141,029	115,427	101,793	93,889	118,136
Collective-owned Enterprises	7,256	9,748	8,157	8,127	8,206	8,299
Cooperative Enterprises	5,120	4,508	3,111	3,506	3,220	3,893
Joint Ownership Enterprises	2,730	1,901	1,423	1,793	2,394	2,048
State Joint Ownership Enterprises	1,782	1,636	1,262	1,414	1,921	1,603
Limited Liability Corporations	423,951	418,484	349,231	312,422	273,193	355,456
State Sole Funded Corporations	111,268	116,775	89,299	96,537	98,853	102,546
Share-holding Corporations Ltd.	235,926	238,715	190,748	156,206	119,909	188,301
Private Enterprises	154,404	134,941	97,150	68,324	52,040	101,372
Other Enterprises	2,678	2,778	2,047	5,204	707	2,683
Enterprises with Funds from Hong Kong, Macao & Taiwan	**149,554**	**136,209**	**85,512**	**71,602**	**49,583**	**98,492**
Joint-venture Enterprises	61,466	56,697	36,766	27,856	20,177	40,593
Cooperative Enterprises	1,994	1,993	946	1,968	1,481	1,676

Enterprises with Sole Fund	74,147	66,530	40,331	35,125	22,991	47,825
Share-holding Corporations Ltd.	11,947	10,990	7,469	6,654	4,934	8,399
Foreign Funded Enterprises	**249,750**	**217,866**	**161,415**	**128,673**	**92,527**	**170,046**
Joint-venture Enterprises	100,614	95,067	74,980	57,537	39,863	73,612
Cooperation Enterprises	1,995	1,613	1,192	1,149	760	1,342
Enterprises with Sole Fund	130,259	100,758	67,818	56,353	39,507	78,939
Share-holding Corporations Ltd.	16,882	20,428	17,425	13,633	12,397	16,153

Source: China Statistical Yearbook, National Bureau of Statistics; calculations. *Note: Data only available for large- and medium-sized enterprises, thus excludes smaller enterprises.